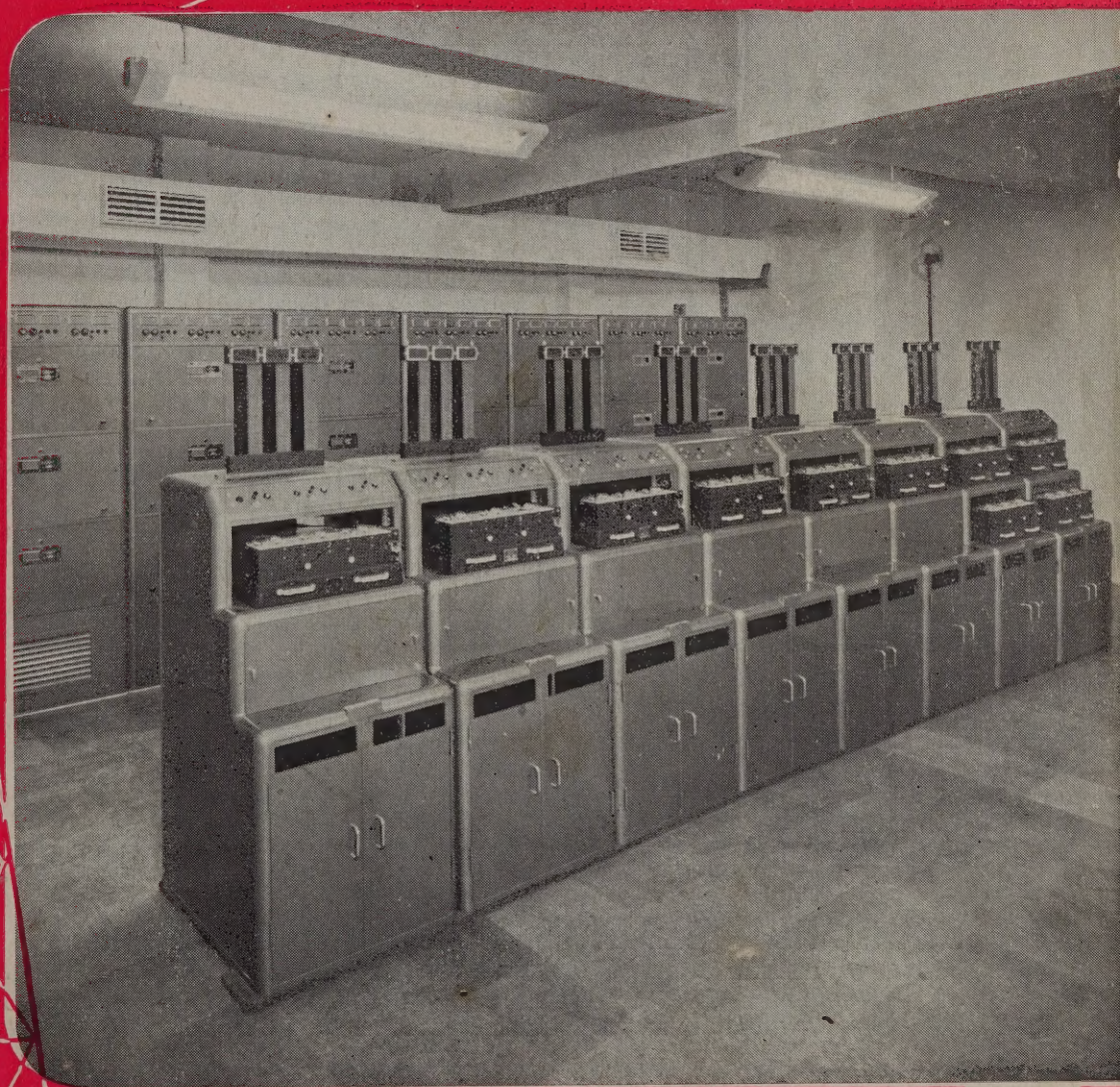
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



JUNE, 1st, 1953 VOL. 8, NO. 4

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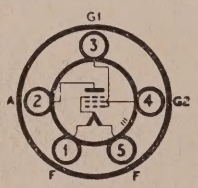
Here's two types you rarely see

BRIMARIZE with a 2A3

Type 45 is a 2.5 volt triode and type 47 a pentode, both of which are still encountered in the output stages of early American receivers.

The triode type 2A3 will replace the 45 directly, and, with minor circuit changes, the 47 also. Substitution of the 47 will result in loss of sensitivity, and the power output will fall unless the output transformer is changed or its turns ratio reduced to match the new optimum load.

Because of the higher filament current of the 2A3, the valve must make good contact in its socket and the leads to the mains transformer must of heavy-gauge wire.



TYPE 47

TYPES 45 & 2A3

CHARACTERISTICS

	47	45	2A3
Filament Voltage	2.5	2.5	2.5 volts
Filament Current	1.75	1.5	2.5 amp.
Anode Voltage	250	250	250 volts
Anode Current	31	34	33 mA.
Grid Bias	-16.5	-50	-50 volts
Bias Resistor	450	1500	1500 ohms
Optimum Load	7000	3900	4000 ohms
Power Output	2.7	1.6	2.0 watts

TYPE	CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
45	U.X. 4 PIN NO CHANGE		NO CHANGE		NONE	NEGLIGIBLE
47	U.X. 5 PIN	U.X. 4 PIN	Pin No. 1 2 3 4 5	Pin No. 1 2 3 Disconnect. Pin No. 4	Change Bias Resistor to 1500 ohms 2 watt and Bias condenser to 25u F. 50 volts working. If fixed bias is employed it must be adjusted to give an anode current of approx. 35 mA. See note.	Reduced Sensitivity. See note.

Note: For maximum power the output transformer turns ratio must be reduced to ¾ of its previous value.

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Radio and Electronics

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Course Of TV Lectures In Wellington

The response to our announcement in the April issue of *Radio and Electronics* concerning the possibility of a course of lectures on the fundamentals of television technique has been most gratifying. In spite of the fact that plans for the course have, up till now been purely tentative, pending some indication of the support that might be expected, a surprisingly large number of people have assisted us by returning the form printed with the announcement. It has therefore been possible to decide that the course will definitely take place in Wellington. A suitable lecture room has been booked, and preparation of the demonstration equipment is now in full swing in our laboratory. A fuller announcement, giving the dates for the Wellington course will be found on page 11 of this issue. We would like to emphasize that those wishing to attend should submit their names as soon as possible, in case it should be necessary, for reasons of space, to limit the numbers. We have been greatly encouraged by the interest and enthusiasm of all who have spoken to us about the course, and of those who have indicated their willingness to attend. So much so that we hope it will not be too long after September before everyone will have an opportunity of putting his knowledge of TV into practical use.

A Demonstration of Sound-Reproducing Equipment

It is well known that the majority of our readers take a great interest in sound reproduction and all that pertains to it. It is only to be expected, then, that we should have awaited with considerable interest a demonstration which took place in Wellington on Thursday and Friday, the 7th and 8th of May, when Messrs. Swan Electric Co. Ltd., in conjunction with the Rola Company of Australia, turned on a demonstration of high-quality equipment for the benefit of the radio trade and industry. Needless to say, the object of the demonstrations was to introduce a new loudspeaker, designed to give high-quality reproduction at a low price, but salesmanship was not allowed to obtrude itself too much into what was in any event a very enjoyable social function.

There are, of course, those who say that high quality and low price are incompatible, but after hearing the demonstration, we are not at all sure that we would agree with them. We do not mean that nothing about the demonstration or its equipment merited criticism. That aspect is being reserved for a separate article in our next issue.

What we are more concerned with at the moment is that such a demonstration was given, before an audience which could be expected to be highly, if not super-critical, and that a very instructive and enjoyable evening was had by all. It is almost unnecessary to say that there are as many different ideas about the electrical reproduction of music as there are people interested. Indeed, the old Latin tag about "tot homines . . . ." was never so apposite as when applied to this subject. The multifarious opinions to be found come not only from the users of audio equipment, but also from its designers and manufacturers, whether they are primarily interested in loudspeakers, pick-up, microphones, recording equipment, or what you will. Each maker of any one of these classes of gear has his own ideas of what is required, and is obviously sincere in his views. Nor is he backward in advertising them, since his livelihood largely depends on efficient advertising. The sort of equipment we are discussing is largely bought and used by enthusiastic amateurs, as well as by professional people, with the result that any particular product which sets out to capture a portion of the "high-fidelity" market soon obtains a reputation which is founded partly on the maker's publicity, and partly on what the individual purchasers think. The latter type of publicity is obtained by the maker whether he likes it or not, and in the case of a thing that becomes popular, can have repercussions which are very favourable, or just the reverse, depending on a number of imponderable factors, such is the fickleness of public opinion. In the long run, of course, true worth will tell, but the vagaries of popular opinion are likely to have considerable effect on commercial success, either one way or the other.

It is perhaps for this reason that it has never been the custom for high-quality audio equipment to be sold on the strength of large-scale demonstrations, in spite of the fact that this would seem on the surface to be the most logical way of impressing on the public the worth of one's wares. The root of the difficulty, however, is to be found in the fact that high-quality audio can never be described in terms of technical specifications alone, because one part of the whole system is outside the designer's sphere of action—namely the ear of the listener. What appears to one as superlative quality can sound repulsive to another, and not at all because of limitations in the equipment, so that no one is to be blamed if they jib at public demonstrations of audio gear.

It is all the more to the credit of the Rola Company, then that they have had the courage of their convictions to the extent of inviting the criticism of professional and amateur alike, no doubt realizing fully that the strictures of the informed amateur can be more devastating than anything else! They have invited criticism, moreover, on the implied basis of much more costly loudspeakers that everyone in the audience must know, and the amount of favourable comment heard round the supper table afterwards certainly indicated that their enterprise was well rewarded. It would be a good thing if these demonstrations were to set a fashion. We might then be treated to less of the uninformed criticism and dogma that seems to abound with regard to reproduced music and methods of attaining it.

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Audiofacts No. 2

Extension Loudspeakers

One of the apparently simple problems of radio, which turns out to be not quite so simple when closely examined, is that of providing a set or amplifier with an extension speaker. It is also one of those cases where the strictly theoretical approach often does not give an acceptable answer in practice. Almost all the practical solutions commonly used represent some sort of a compromise, so it is just as well to know what are the factors involved, and what liberties can be taken with the theoretical answer while still giving satisfactory performance.

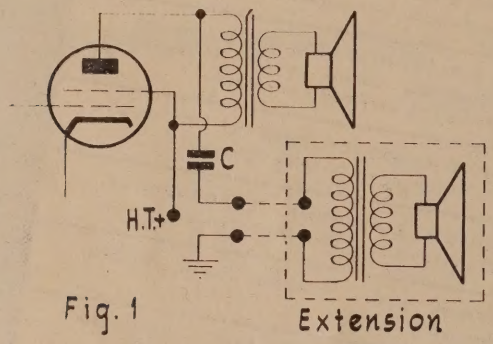

Fig. 1

MATCHING THE TWO SPEAKERS

Since the designer of a set or amplifier is careful to ensure that the speaker is correctly matched to the output stage, the first and most obvious question is whether adding a second speaker will upset the conditions under which the output stage has to work. Theoretically, adding a second speaker requires that each speaker should have its own secondary on the output transformer, or at least its own tap on a tapped secondary winding. Suppose, for example, that the two speakers have identical impedances—say 15 ohms each. If the loading on the amplifier valves is to be the same whether one or both speakers are in use, then the secondary windings to be used when both are working will have a different number of turns from the winding which feeds only one of them. It is thus impossible to retain correct matching if the main speaker is left connected to its original winding, and the other speaker is connected to the amplifier in any way at all. The correct solution theoretically would be to have three windings on the secondary side. One of these would be used when only one speaker was connected, but when both were working, the other two windings would be used, leaving the original winding unconnected. With this arrangement, a fairly complicated system of switching *could* be devised which would connect both, or any one of the two speakers, while still preserving a correct match for the output valves and the speakers themselves. Unfortunately, such a procedure would mean installing a new output transformer in the set. To make matters worse, the new transformer would not be a stock item, and would have to be specially made. Altogether, the job would be quite a costly one, and even after it was done, we would still find it necessary to increase the volume setting in order to retain the same volume in each speaker that we originally had in the main one, should this be desirable. Going to such lengths might be worth while when a home sound installation was being planned, and if it was essential to have just as good results from the secondary speaker as from the main one, but for ordinary extension speaker work, it is much too "high-falutin'" and costly. In general, an extension speaker is a small unit, with no pretensions at all to high-fidelity, and which is only required to handle a small output power. Usually, too, it is not in use when the main speaker is, so that any drop in level in the main speaker when the extension speaker is switched in is not worth

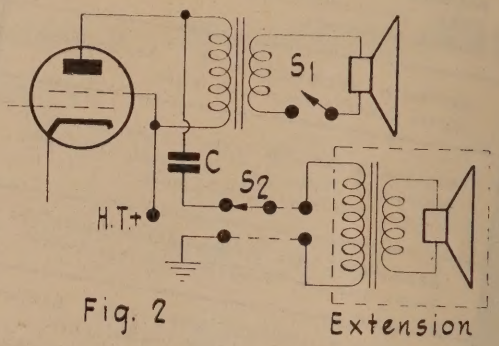

Fig. 2

worrying about. Neither is any mis-match that occurs in either speaker, unless it is so gross that it is impossible to get a reasonable amount of volume without distortion. It does not seem to be generally realized that absolutely correct matching is important only when maximum power output must be obtained together with a minimum of distortion. Quite large mismatches can be tolerated without any noticeable effect on the listener, and after all, that is what matters most.

PRACTICAL SCHEMES

One very common way of connecting an additional speaker is shown in Fig. 1. Here, two terminals on the back of the chassis (or a 'phone jack) feed the primary of the extension speaker's transformer, through a blocking condenser. Now even with this simple circuit there are a number of possibilities. If the extension's transformer matches it to the same nominal load impedance as does the main speaker's, then the power will be shared equally between the two speakers. All that will happen apart from that, is that the load on the output valve will be halved when both speakers are working, and this will simply reduce the maximum undistorted power output of the output valve. Unless an attempt is made to work both speakers at something like the full volume obtainable from the one main speaker, the reduction in power output will never be noticed at all. The arrangement is therefore an entirely practical one. Most receivers using a single 6V6 or similar valve in the output stage have output transformers matching the speaker impedance to 5000 ohms. Thus, it is quite safe to obtain an extension speaker whose transformer also matches to 5000 ohms. If the extension speaker has a transformer matching it to, say, 10,000 ohms, it can still be used, but the power will then not divide evenly between the two speakers. The one with the 5000-ohm transformer

will get twice as much power as the one with the 10,000-ohm transformer, so that in the example mentioned, the extension unit will make less noise than the main speaker. This sort of performance is often desirable in any case, as for example, when the main set is in a large room, and the extension is in a small one, such as a kitchenette. It also has the advantage that the mismatch caused on the output valve is less than that when both transformers are the same. With two

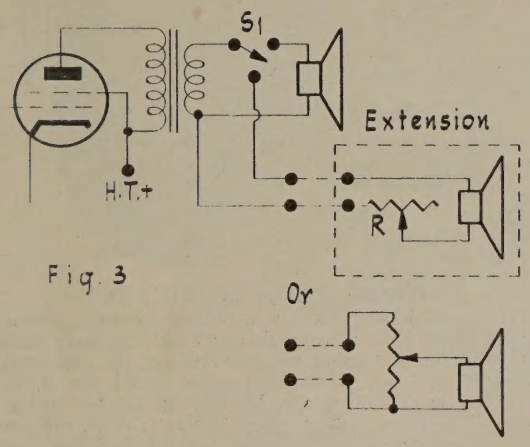

Fig. 3

5000-ohm transformers, the output valve is actually loaded by 2500 ohms when they are both in use, but with the 5000 and 10,000 ones, the load on the output valve is 3,300 ohms—much closer to the "official" figure of 5000, that the tube requires.

With this circuit, it is important that the blocking condenser should be large enough, otherwise the reproduction from the extension speaker will be lacking in bass. Fortunately, large condensers are not necessary, and a condenser of 0.25 μf. will give quite satisfactory reproduction down to 100 c/sec. There is, in any case, no point in aiming at extending low frequency response, because small extension speakers are never well enough baffled to have much bass response anyway. However, should the extension speaker be a good speaker, properly baffled, so that frequency response is a consideration, a condenser of 1 or 2 microfarads will be quite large enough in cases where the transformer primary impedance is 5000 ohms. In cases where it is larger than this, the capacity may be reduced in proportion. For example, a condenser of 0.5 μf. with a transformer primary of 10,000 ohms will have the same bass response as one of 1 μf. with a transformer primary of 5000 ohms, and so on. Incidentally, be sure to use a condenser which has a high enough voltage rating. There are a number of war surplus 1 and 2 μf. condensers about, with voltage ratings of only 15 or so. These should certainly not be used. It would be better to play safe and use a 450- or 600-volt condenser, for should one break down, the damage could be considerable.

ONE SPEAKER AT A TIME

With the scheme of Fig. 1, it is possible to make a simple modification, which is shown in Fig. 2, to enable only one of the two to be on at once. The only disadvantage of the arrangement is that it is no longer possible for both to be on together. The two switches can both be on a single wafer switch. For this, the transformer impedances clearly need to be identical.

Both the previous schemes involve running the lines to the extension at high impedance, with a relatively high audio voltage on them. An alternative, which has advantages, is to feed the extension from the voice-coil winding of the main speaker. When this is done, the voltage on the line is very small, but the current through it is correspondingly larger, so that care has to be taken not to use too fine wire. If the resistance of the line is too high, power will be lost in it. However, the requirements are not very severe. The following table, taken from the third edition of the *Radiotron Designer's Handbook*, shows the lengths of line that can be used with various voice-coil impedances and wire sizes, for an arbitrary loss of 15 per cent. in the power delivered to the speaker. It will be seen that for low-impedance speakers, the permissible lengths are quite small if fine wire is used. On the other hnad, very fine wire can be used for considerable distances if the voice-coil impedance is even as high as 15 ohms.

Where secondary connections are used, the same relationships hold as in the previous case, with regard to the power division between the speakers. For instance, if the voice-coil impedances of the speakers are the same, the power will divide equally, but just as before, the load on the amplifier will be halved. Similarly, an extension speaker which has twice the impedance of the main one will take a third of the power, leaving the remaining two-thirds for the main speaker, and reducing the load impedance to 66 per cent. of the original value.

VOLUME CONTROL FOR THE EXTENSION SPEAKER

It is often inconvenient to have to go back to the main speaker's position to adjust the volume from the extension speaker, so that a volume control is desirable as a simple addition. Fig. 3 shows two ways of doing this. The series method causes the extension speaker to be mismatched at low volume levels, but this is of only minor importance, and the circuit has the advantage that at low volumes from the extension, it has a negligible effect on the volume from the main speaker. The resistor in the series connection should preferably have a maximum resistance of about 20 times the voice-coil impedance of the speaker, but even this will not reduce the volume level to zero. This can be done, however, by using a variable resistor in which there is a gap at one end, so that by turning the control fully anti-clockwise, the slider is open-circuited.

With the parallel arrangement, R should be not less than 5 times the impedance of the voice-coils. When this is the case, the loss in audio power is small, and will be unimportant for ordinary domestic purposes.

In Fig. 4 is shown a satisfactory method of switching either or both speakers into circuit. The resistance R should have a resistance equal to the voice-coil impedance of the speakers. When this is the case, there is no change of volume as the switch position is changed, since the load on the valve is constant. If this system is used, it is advisable to have the output transformer of such a ratio as to match the plate of the output stage to half the impedance of one speaker. In this case, the correct matching conditions for the valve are always obtained, irrespective of the position of the switch. The circuit does, however, limit the maximum power that can be fed to each speaker to one-half the maximum power output of the amplifier.

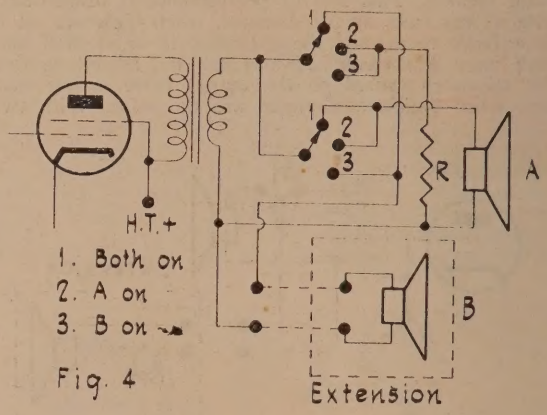

Fig. 4

ALTERATION TO THE SET

If it is desired to use this arrangement, but it is necessary to have each speaker fed with the same amount of power as was originally provided for the one speaker, a simple solution, if room can be found for it, is to modify the output stage by adding another valve in parallel with the output valve. If this is done, the power output of the output stage is doubled, and the correct matching conditions are preserved for the valves, without changing the output transformer. Since the actual load impedance has been halved, and because two valves

(Continued on Page 47.)

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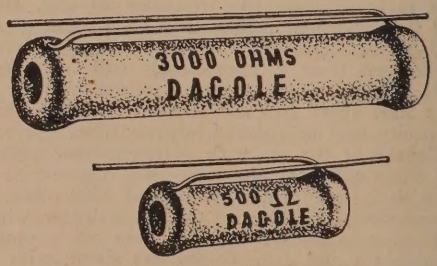

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Model	Power Handling Capacity (Watts)	Frequency Range (C.P.S.)	Voice-Coil Impedance (Ohms at 400 C.P.S.)	Transformer Type
6H	4	90-6,500	3.7	D
6-9H	4	85-5,500	3.7	D
8H	4	80-6,000	3.7	D
8K	5½	80-6,000	2.0	C
8M	7	80-6,000	2.0	C
12M	7	75-5,500	2.0	C
12.0	7	65-6,500	2.0	C
12.0x	6	50-12,000	2.0	C
3C	¼	225-8,500	3.7	G
5B	2½	130-6,500	3.7	F
5F	3	130-6,500	3.7	G
4-6H	3	130-6,500	3.7	G
6L	5	35-6,500	3.7	D

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A V.F.O. for the V.H.F. Transmitter

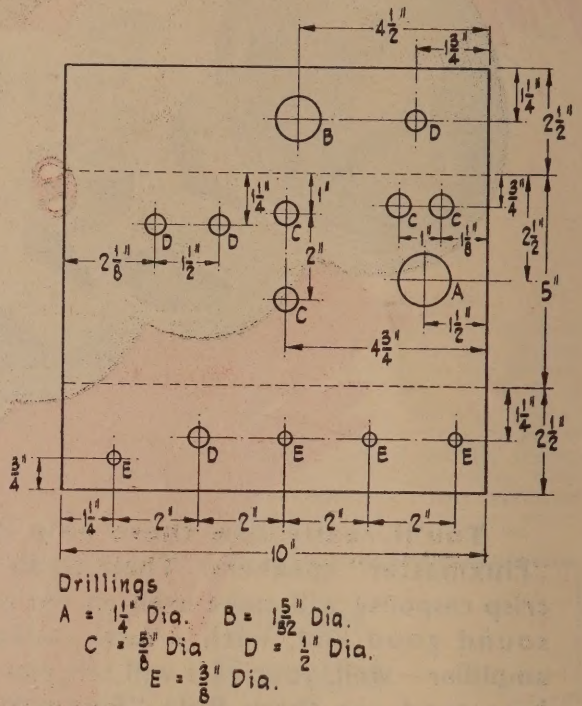
In the last issue of Radio and Electronics, *the first part of this article described the circuit of the V.F.O., which is a Clapp oscillator covering the range 46.6 mc/sec. to 54 mc/sec. This is followed by a Class A buffer, and an output tetrode giving six to seven watts output over the band. This instalment describes the construction of the prototype built in our laboratory.*

PART II—CONSTRUCTION OF THE V.F.O. AND EXCITER

The unit is built on a chassis 10 in. x 5 in. x 2½ in. deep, a drawing for which appears here. The tuned circuit components of the oscillator are mounted in a small aluminium box 2½ in. x 2½ in. x 3 in., which is mounted to the chassis by three bolts. The coil is mounted on a stand-off insulator at one end, and one stator post of the variable condenser at the other. A second stand-off is used as a tie-point for the two 50 $\mu\mu$f. condensers, C_2 and C_3 in the circuit diagram, which are in series from one end of the coil to earth. Their junction, and the upper end of the coil are the only points of attachment of the tuned circuit to the oscillator valve, and this method of mounting makes both of them as firm as possible. Under each stand-off insulator is a hole through which the heavy connecting wires are taken. There are corresponding holes in the main chassis, so that in the underneath view, the bottoms of the insulators can be seen, with the wires coming away from them. In using the insulators in this way, as feed-throughs, the bolt is unscrewed, and the wire made into a loop and inserted into the hollow part of the porcelain before putting back the bolts. These are then re-affixed with their nuts in the usual way, and mounted to the inside of the box. This method is just as good as using proper feed-throughs, and makes the box somewhat easier to mount.

Beside the box, and enclosed in a shield, is the EF91 oscillator valve, and behind it in the top-chassis view is the second EF91, which is the Class A buffer. Because this valve works on the same frequency as the oscillator, shielding is important if it is not to oscillate on its own account. In the underneath view, a baffle-shield can be seen, attached to the back of the chassis, and crossing the socket of the amplifier tube. This isolates the oscillator circuit both from the Class A stage and from the Class C output valve and its circuit, at the same time forming a cross-socket shield for the buffer. The second baffle-shield is another piece of aluminium attached by flanges to the front edge of the chassis, and to the first baffle-shield. The longer portion of the second shield crosses the socket of the QV04/7 so as to place the grid pin and three others, inside the output compartment of the buffer. The QV04/7 socket is a nine-pin one, the same as those used for EF50s, and the socket is turned so that pins 5, 6, 7, and 8 are on the left-hand side of the shield partition (in the photograph). These are, respectively, the connections to the internal shield, the cathode, the control grid, and the internal shield again. Thus, all except the grid pin are earthed, and this, with the baffle-shield separating it from the plate pin, effectively prevents instability due to coupling between grid and plate outside the valve.

The variable condenser in the centre of the chassis front is the tuning condenser for the buffer, C_6 on the diagram. The coil for this circuit is mounted with its axis vertical, and so is hard to see in the photograph,

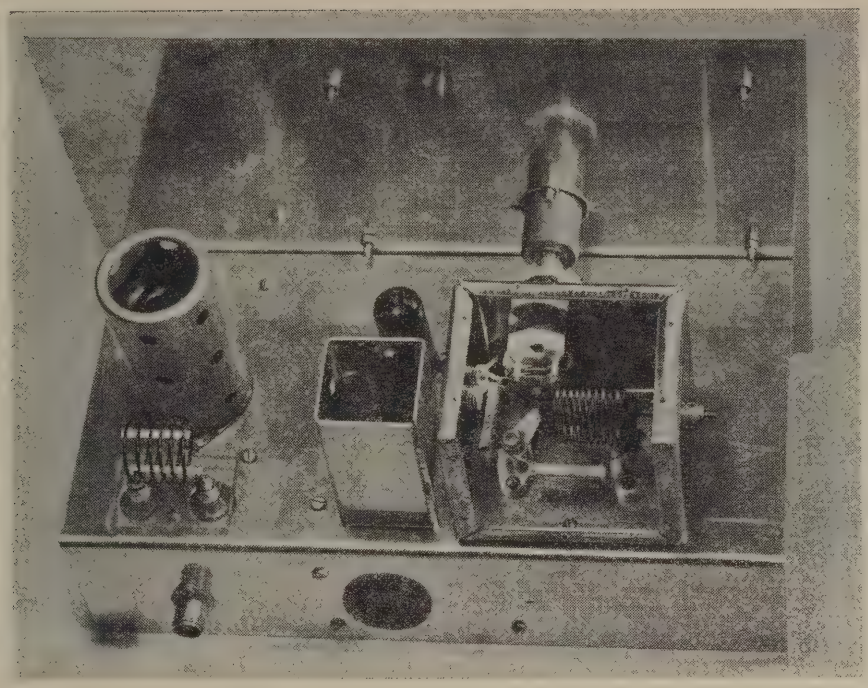


but its upper end is mounted on the small tag-strip which can be seen fixed to the front side of the baffle shield, exactly over the valve socket, and opposite the tuning condenser. Its lower end is fixed to one stator post of the variable condenser.

Both tuning condensers for the output tank circuit are mounted on the second baffle shield, and are operated through extension shafts and flexible couplings, which can be seen in the photograph. The one near the junction of the baffle shields is C_{13}, the one connected to the output terminal. C_{12}, which connects to the plate of the QV04/7 in the diagram, is mounted on a small bracket which is itself screwed to the side of the baffle-shield.

A CIRCUIT OMISSION

In the circuit diagram, a fixed condenser was omitted. Leaving it out would not prevent the final from working unless there was a direct connection to earth from the output terminal, but in any case would place H.T. voltage on the components of the output tank. There should be a blocking condenser between the plate of V_3 and the junction of C_{12} and L_3. It is 100 $\mu\mu$f. in size, and cannot be seen in the under-chassis photograph, being hidden by the condenser's extension shaft. It should on no account be omitted.



examined, a very small variable condenser can be seen at the left of the coil box. This is an ultra-midget variable condenser of 10 $\mu\mu$f. maximum capacity, which is connected in parallel with C_1, the oscillator tuning condenser. It has four rotor plates and three on the stator, and the whole thing is mounted on a minute base only $\frac{3}{4}$ in. x $\frac{1}{2}$ in. These are excellent in that they can be adjusted through a hole in the side of the chassis, without taking off the lid of the box. However, if you cannot come by these, a Philips trimmer will be quite satisfactory for the job. In practice, this condenser was used at about a quarter capacity, simply to centralize the required band of frequencies on the dial, and in conjunction with the inductance trimmer about to be described.

MOUNTING OF THE OUTPUT TANK COIL

Although the circuit does not call for it, the output tank coil is mounted plug-in fashion, just in case a change of frequency range might be needed at some time. The mounting is home-made, from two banana sockets and a piece of sheet perspex or polystyrene. The sockets are mounted in it, the right distance apart, which is exactly one inch, and two holes are made in the chassis, with centres one inch apart. They were made in our own case with the $\frac{5}{8}$ in. socket punch used for miniature sockets. This leaves plenty of space round the sockets for useful insulation material. The coil is made by mounting the two banana plugs in another sheet of perspex. After the fixing nuts have been put on, the threaded portions of the plugs are filed down level with the nuts, and liberally tinned with solder. Then, when the coil has been wound, it is mounted simply by soldering the ends of the coil to the prepared ends of the plugs. Then, to add stiffness, two pieces of heavy drawing paper, about an eighth of an inch wide, are stuck to the turns of the coil with polystyrene dope. These stiffeners can be seen in the photograph, and are also used on the oscillator coil, though they cannot be seen so readily. In the photograph, the lid of the box, which covers the top and back has been left off.

PRE-SET ADJUSTMENTS FOR THE OSCILLATOR COIL

Although they do not show in the circuit diagram, the actual oscillator unit was provided with means for trimming both the inductance of the coil, and the minimum circuit capacity. If the photograph is closely examined, a very small variable condenser can be seen at the left of the coil box. This is an ultra-midget variable condenser of 10 $\mu\mu$f. maximum capacity, which is connected in parallel with C_1, the oscillator tuning condenser. It has four rotor plates and three on the stator, and the whole thing is mounted on a minute base only $\frac{3}{4}$ in. x $\frac{1}{2}$ in. These are excellent in that they can be adjusted through a hole in the side of the chassis, without taking off the lid of the box. However, if you cannot come by these, a Philips trimmer will be quite satisfactory for the job. In practice, this condenser was used at about a quarter capacity, simply to centralize the required band of frequencies on the dial, and in conjunction with the inductance trimmer about to be described.

It is not essential to have an inductance trimmer, since the inductance of the coil can be adjusted within

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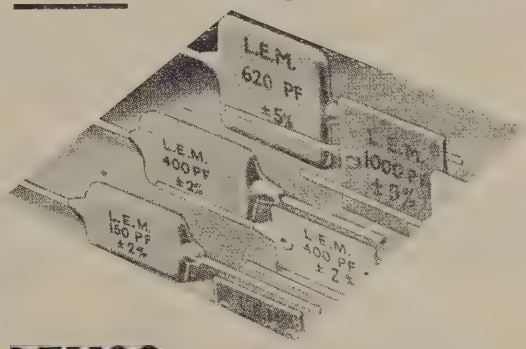

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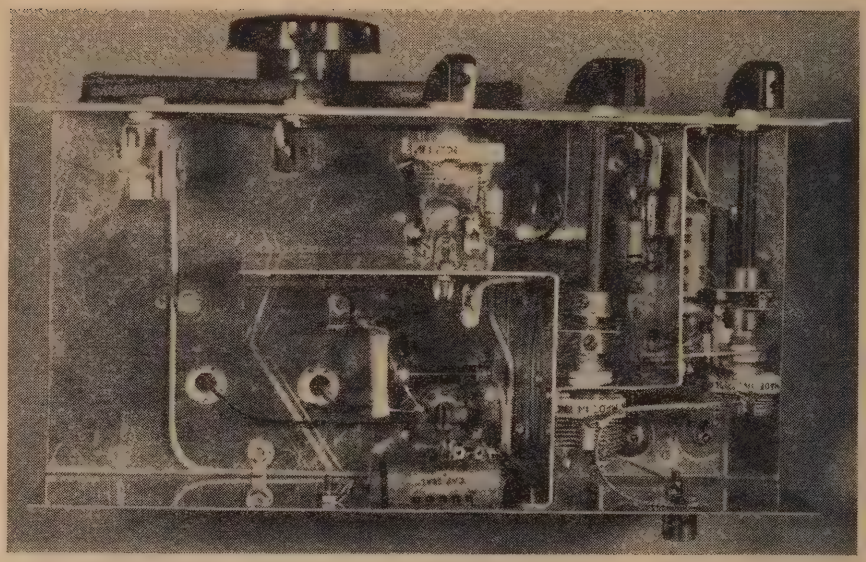
quite wide limits merely by squeezing or spreading the turns of the coil slightly. The trimming device, however, makes the final adjustment a little more quickly done, because with it and the midget variable condenser, final adjustment of the frequency range can be carried out without taking off the lid of the coil box. The inductance trimmer consists of a copper "slug," fitted to the end of a piece of threaded rod, and fixed to the side of the box by means of a threaded bush. The slug can be adjusted from outside with a screwdriver, and fixed in its final position by tightening a locknut on the outside.



The diagram printed here shows the calibration curve of the original model illustrated in the photographs. The dial reads from 0 to 100, and the curve can be seen to be almost a straight line, indicating that the band-spreading obtained is nicely linear, without any crowding at either end of the frequency

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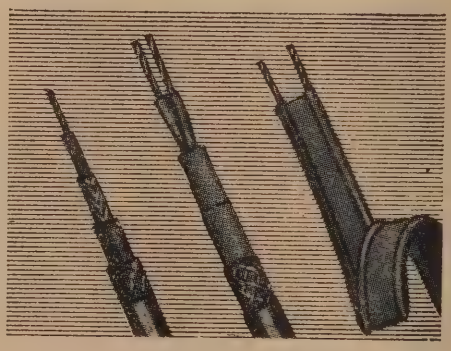
		PT.29.M.	

BALANCED TWIN (Screened)
BA.24.PSM. BA.3.PSM.
K.12.SM.



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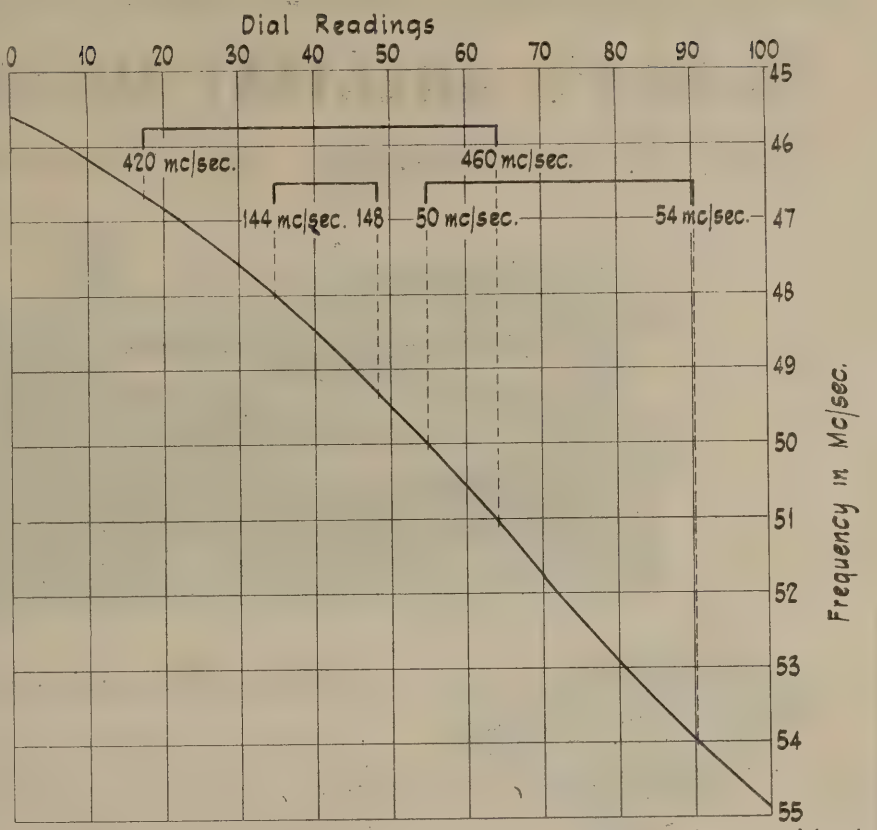
range. There is adequate overlap to ensure that none of the required frequency range is missed out, without wasting dial space unduly.

When the unit is completed, only one dial calibration need be carried out, at the fundamental frequency of the oscillator, and the two higher bands can be marked in, preferably in coloured inks, much after the manner used on the diagram. While this will not show exact frequencies inside the higher bands, these can easily be worked out from the oscillator frequency scale by multiplying by 3 or 9 as the case may be, and if desired, the round figures for the 144 and 420 bands can be marked on their respective dial scales.

With this unit as a starting point, there is no reason why anyone should have difficulty in finding the two higher bands quite accurately, and even if the exciter is not used as an actual signal source, it can always be used as the basis of a beat-frequency-meter, in order to spot the exact frequencies of self-excited oscillators on the higher bands. However, with a stable V.F.O. available, much the best plan is to multiply up to the other bands, and future articles in *Radio and Electronics* will show how this can be done.



TV Lecture Course

The course of TV lectures which has been publicized in the April and May issues of *radio and Electronics*, has received excellent support, and will now definitely take place, on the following dates in the lecture room of the New Zealand Educational Institute, Evening Post Building, Willis Street, Wellington:

1st Lecture, Monday, 7th September.

2nd Lecture, Tuesday, 8th September.

3rd Lecture, Wednesday, 9th September.

4th Lecture, Monday, 14th September.

5th Lecture, Tuesday, 15th September.

6th Lecture, Wednesday, 16th September.

7th Lecture, Thursday, 17th September.

8th Lecture, Tuesday, 22nd September.

9th Lecture, Wednesday, 23rd September.

10th Lecture, Friday, 25th September.

Fees

The fee for the course will be four guineas (£4 4s.), payable in advance to Radio and Electronics (N.Z.), Ltd., P.O. Box 8022, Wellington. Receipts will be issued immediately, and admission tickets will be forwarded later.

Previous Reading

Those expecting to attend are recommended to buy and read a copy of "The Principles of Television Engineering," by A. W. Keen. This should avoid the necessity for taking lengthy notes during the lectures. We have made arrangements for leading booksellers to have copies available shortly.

Acceptance of Entrants

The size of the lecture room may cause us to limit the numbers attending. All those who have already sent in their names will be sure of acceptance, but others are urged to book in early to avoid possible disappointment.

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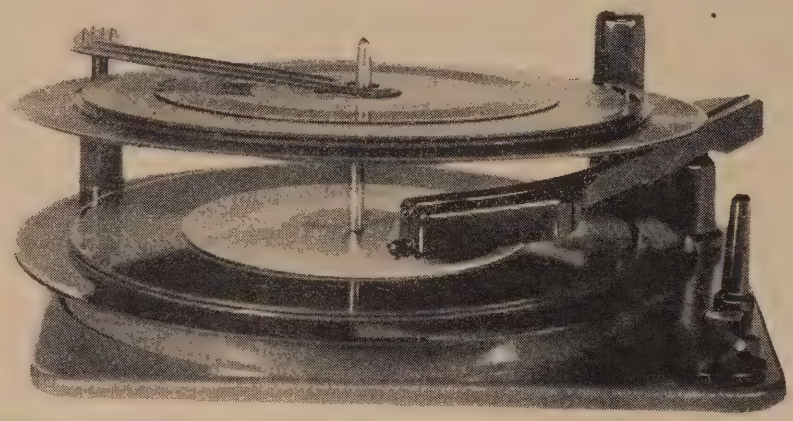

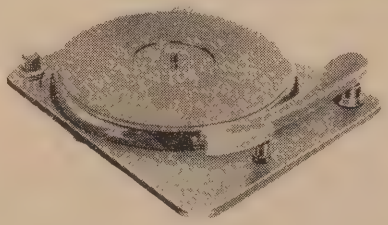

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The Uses and Duties of a Laboratory in a Radio Manufacturing Firm

There are number of reasons why an organization engaged, among other things, in the production of radio receivers, should have available the services of an adequately staffed and equipped laboratory. The first and most essential of these concerns the production of domestic radio sets themselves.

RADIO SET PRODUCTION

The prime purpose of the laboratory is to design the sets that the factory is to make, and in doing so, to ensure that the factory has well-designed receivers to produce. The factory's function being to operate production lines, it must at all costs be relieved of any doubt that the models it turns out might be subject to systematic faults which could have been foreseen, or at least eliminated in the design stages. In general, it is more profitable to spend a certain amount of money in ensuring that the prototype is in every way suitable for production than to spend it in remedying faults after the sets are built, or in making modifications which, however necessary they may be, inevitably upset the production line for a time. Time spent by factory personnel in this sort of work represents loss of production that can be avoided if there is a properly constituted laboratory, carrring out its functions satisfactorily.

A factory which sets out to manufacture a local copy of a set originally designed elsewhere, needs a laboratory no less than does a factory producing entirely original designs. The main reason for this is that the locally built copy will hardly ever be a true copy, i.e., one in which all component parts are identical with those used in the original. The moment such changes are made, even in a small and relatively simple receiver, it ceases to be the product of the original designer, and in consequence is likely to develop characteristics not possessed by the original. Only the designer can tell whether small modifications are likely to make a significant difference to the performance of the product, and even he, in many cases, coud not give a satisfactory answer without recourse to experimental work. When a number of such changes are made simultaneously, there is every likelihood that additional, unforeseen modifications will be needed before the design is once more suitable for production.

A further important function of the laboratory is in connection with actual production, even when a small pilot run has been successfully undertaken before embarking on the main run. As a result of the ultimate complexity of even the smallest radio set, it is inevitable that a certain number in each run should be unsatisfactory, through faults that cannot be blamed on the design. Some of these can be put right by those responsible for initial testing and alignment, but many cannot, since testers cannot afford the time to track down relatively obscure faults.

It should be a duty of the laboratory, not only to investigate and cure faults not able to be handled by the testers, but also to analyse records of all faults in newly produced sets, including those found by the testers and rectified by them. In this way, recurring faults due, for example, to a poor batch of components, can be "spotted" at the earliest possible moment. This is important in view of the high cost of setting right sets which are unserviceable when they come off the production line. In addition, the doing of this work by the laboratory provides the designer with very useful data, which he can employ while other sets are in the design stages, in order to prevent recurrent troubles that experience has shown can appear in spite of good work by both the laboratory and the factory.

The third function of the laboratory is to initiate and pursue technical ideas not yet incorporated in any of the firm's products, but which, when properly developed, will enable models to be produced, having new features which will not only improve the product, but which will also act as "pegs" on which to hang soundly-based advertising copy. With respect to smaller and less expensive sets, such new ideas are difficult to find owing to the nearly standardized state of their development, but the same does not hold for the higher-priced models, and in particular for radio-gramophones. In spite of their more limited sale, it is the higher-priced models which should set the standard by which the firm's products are judged. This is especially true at the present time, when there are indications that the public is becoming more and more conscious of the quality of reproduction (or lack of it) provided by a set. Few, if any, standard commercial radio-gramophones on the market today can approach the quality of reproduction of even a medium-priced custom-built installation. As a result, much money is being spent on such systems which could reasonably be expected to buy commercial radio-gramophones, did the latter possess better performance. While no laboratory can design an outfit which will equal in performance a highly-priced custom installation, at a consumer price that is much smaller, there are certain features

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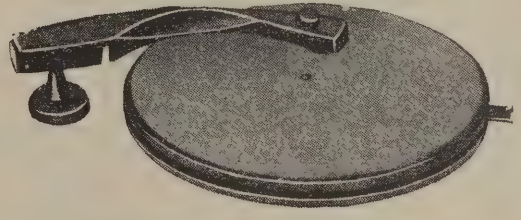

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which could well be incorporated in a firm's radio-grams, and which would result in greatly improved performance.

This matter has been treated in some detail, simply as an example of how a laboratory can play an exceedingly important part in maintaining and building up the prestige of the firm's products, and it is only by competent design work, related not only to performance of the product, but to the economics of its production, that a firm's sets can better those of its competitors.

OTHER FUNCTIONS OF A LABORATORY

All the above refers solely to the production of domestic radio sets. Many firms have made use of their laboratories, originally set up for the purposes outlined above, to expand the types of business handled by the factory, and to enable the firm to market highly technical products not made in its own factory. For example, not only can the laboratory pursue the technical development of new products upon which the management proposes to embark, but it can also act as an advisory centre for the firm's handling of special products such as tape recording machines, which require expert servicing. The laboratory can also play a useful part by making technical reports to the management on any new articles or devices which are being considered as lines to be handled.

The electronic field is a very rapidly expanding one, and the laboratory can be the means by which a firm begins to do business in special equipment, of the sort which has to be designed and built to given specifications.

TELEVISION

All the remarks which have been applied to the production of radio sets apply with vastly increased force if and when the firm becomes involved in producing television receivers. It is not too much to state that such production would be impossible without the backing of at least one highly qualified engineer, supported by suitable assistants. There should be no need to labour the point after it is pointed out that the smallest number of valves normally found in a television receiver is about 15, not counting the picture tube, and that many of these valves perform functions that are considerably more complex than those of any valve in an ordinary radio set.

CONCLUSION

The above dissertation is not a plea for the employment of technical men. It is an appreciation of certain facts relating to the primary purpose of a commercial undertaking, which is to turn out an article of good quality, and in so doing, to make profits. If a firm considers that its operations are not large enough to maintain a well-qualified engineer and a small staff of one or two assistants, it should carefully weigh the cost of so doing against the time and money that can be saved by eliminating unproductive work in the factory itself. Such time is doubly saved, by virtue of the fact that it can then be applied to greater production. It does not take many radio sets, and fewer still television receivers, to make up the expenditure on a small laboratory, especially after the capital expenditure involved in equipping it has been made.

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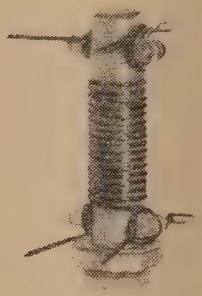

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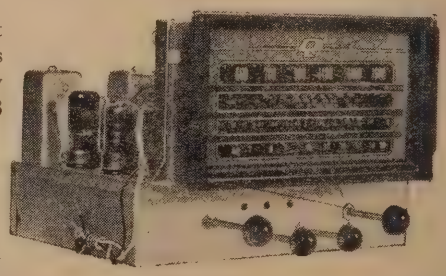

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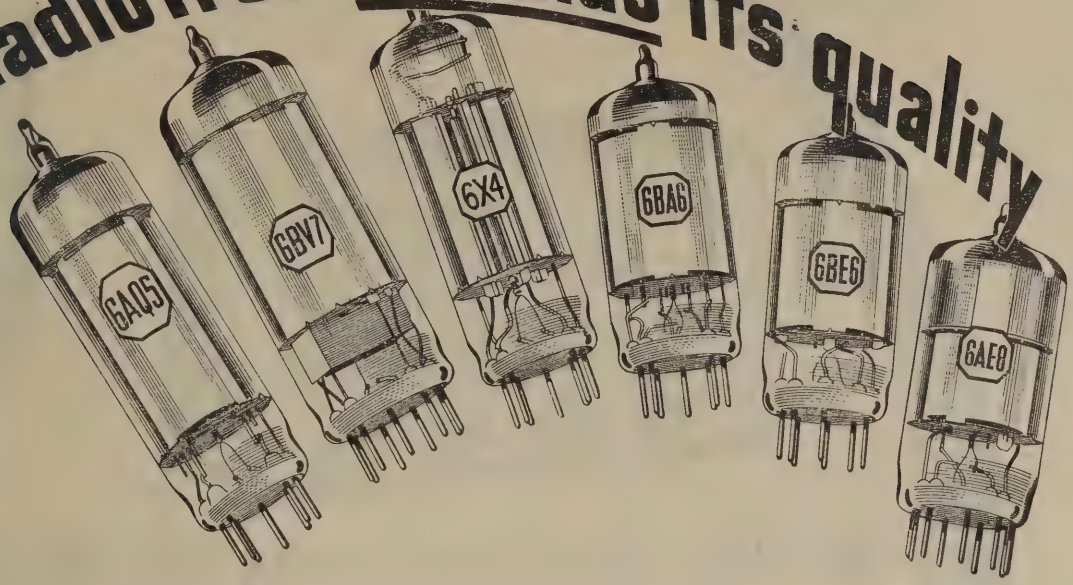
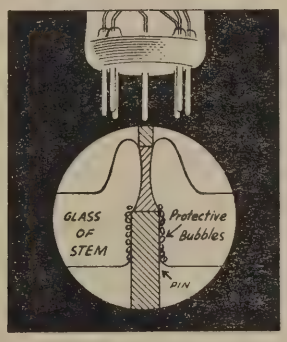


The ability of Radiotron Valves to function at the high standard for which they are designed is not left to choice. Quality is *in-built* into every Radiotron. The illustration shows one example of this in-built quality—that part of the manufacture of a valve in which the pins are embedded in glass at the base of the valve.



A casual observation shows that the glass base, in a molten state, has been moulded around the leads. However, what the eye does not see is a group of protective gas bubbles surrounding each pin to act as a shock absorber to any inward or outward movement of the pins. This process is made possible by the fact that in Radiotron Valves only carefully selected wire, having a fixed gas content, is used. Molten glass is forced around these pins, and the heat of the operation causes the absorbed gases in the wire to come to the surface and be trapped between it and the glass as shown.

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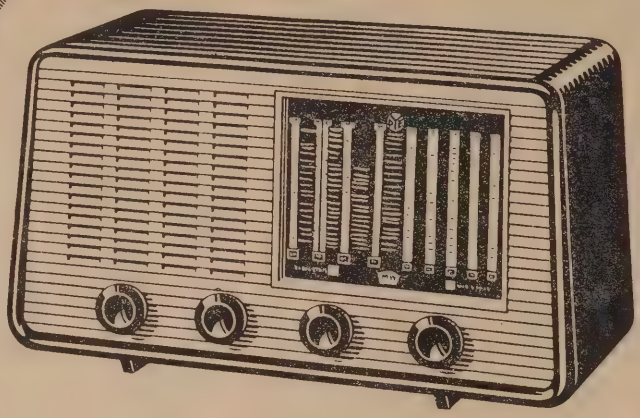

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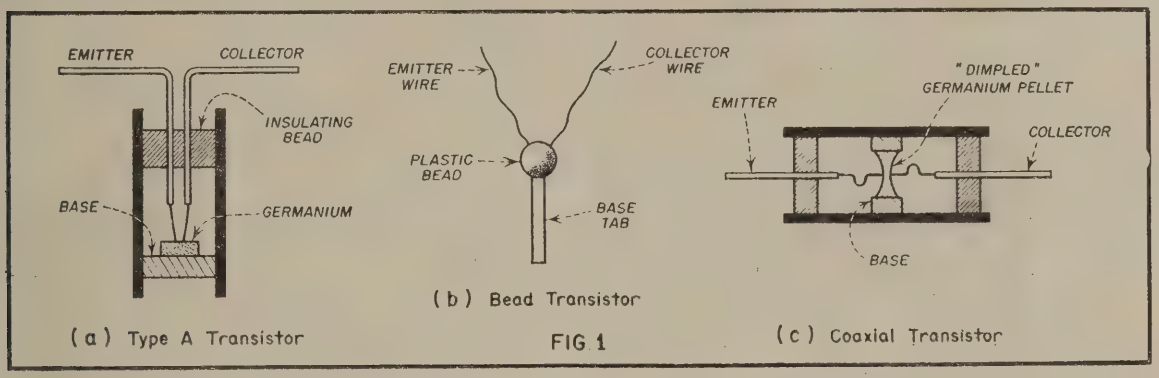
P23

Recent Developments in Transistors

By the Engineering Department, Aerovox Corporation

The March, 1950, issue of *Radio and Electronics* contained a discussion of the operating principles of the semiconductor triode, or *transistor,* which had recently been announced and was then making its debut in the field of electronics. At that time, the future of the device was obviously bright, although little was known of its ultimate potentialities nor the seriousness of some of its shortcomings. Now, after only a few short years of intense development, the transistor has emerged from the category of a "crystal ball" innovation to assume the important role predicted for it by the great research organizations which fathered it.



(a) Type A Transistor (b) Bead Transistor (c) Coaxial Transistor

FIG. 1

Standardized types of transistors have come into being, and many commercial and military equipments have been completely *"transistorized,"* a new term meaning the replacement of all vacuum tubes by semi-conductor diodes or triodes. Although many technical problems still remain to be solved, and the semi-conductor triode is still in its infancy, the only factor which prevents its wholesale appearance in hearing aids, midget radios, intercommunications equipment, telephone amplifiers, and many other applications at this time is the problem of availability. When transistor production reaches the point where the supply is sufficient to meet the demand, the man in the field may awaken one day to find himself confronted with the unfamiliar circuitry of the transistor. This article is intended to help readers meet this eventuality by presenting a condensed review of the present transistor art.

NEW TRANSISTOR TYPES

The transistor introduced originally was known as the *point contact* type, later designated Type A. The configuration of this type is the familiar double "catwhisker" arrangement shown in Fig. 1A. Two fine wire probes are arranged in contact with the surface of a pellet of germanium semi-conducting material at points only a few thousandths of an inch apart. One of the contacts is designated the "emitter", while the other is called the "collector." The semi-conductor block and the metal which provides the electrical connection to it are called the "base."

The operation of the Type A transistor was discussed at length in the above-mentioned number of *Radio and Electronics.* The defects which characterize it are difficulty of construction, low power handling capabilities, poor noise characteristics, and undue temperature sensitivity. At least the first two of these shortcomings are due to the fact that the points of contact with the germanium must be very accurately spaced and are extremely small areas. For this reason, even a few milliamperes flowing through these contacts represent current densities of many *amperes* per square centimetre. The excessive noise, which in instances exceeded 70 decibels above that predicted by theory, and the temperature dependance, may be inherent properties of semi-conductors, although subsequent types have been vastly improved in these respects.

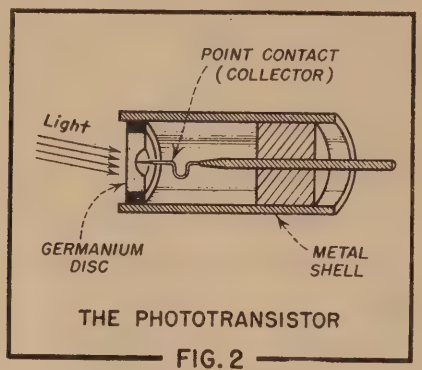
A varient of the standard Type A transistor is the "bead type" transistor illustrated in Fig. 1B. This form is a *miniaturized* version of the Type A which has been reduced to its very small size by eliminating the capsule and other non-essential parts. The two phosphor bronze contact wires and the small germanium block, along with a base contact tab, are "potted" in a small bead of insulating material which maintains the proper contact spacings. Bead types have been standardized which compare favourably with the larger sizes in performance. They are useful in applications where extreme miniaturization is necessary.

A third form of the point-contact transistor is the coaxial configuration illustrated in Fig. 1c. Here the two "catswhiskers" make contact with opposite sides of the semi-conducting germanium material where it is very thin—about .003 to .005 inch. This thin section is produced by grinding the opposite sides of the pellet to the concave shape indicated in the figure. In this manner, the problem of maintaining the close spacing of the wires is somewhat alleviated and the tendency of the point contacts to slip sideways, as in the Type A construction, is minimized because the wires are coaxial and perpendicular to the surface of the semi-conductor. Another advantage of the coaxial construction shown in the figure is the fact that the emitter and collector are electrostatically shielded from each other by the semiconductor and the metal shell.

Although comparable in performance, the coaxial transistor does not seem to have found such widespread usage as the type A transistor as yet.

THE PHOTOTRANSISTOR

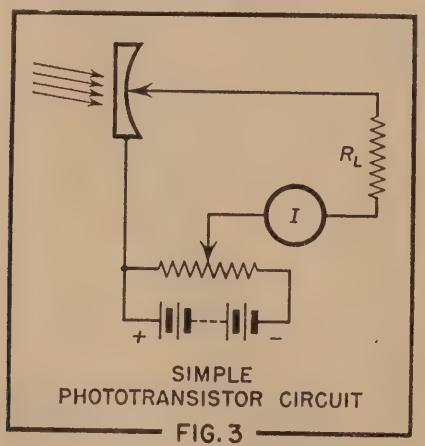
An extremely useful by-product of the coaxial embodiment of the point contact transistor is the *phototransistor* illustrated in Fig. 2. This device makes use of the fact that the conductivity of germanium is altered



THE PHOTOTRANSISTOR

FIG. 2

by incident light energy, i.e., germanium is *photoconductive.* This property makes possible a very small photocell built like the coaxial transistor, except that the function of the emitter electrode is performed by a beam of light which strikes the semi-conductor surface opposite to the one which the collector contacts. The germanium must be ground very thin at this point, as in the coaxial transistor. Otherwise, the "holes" liberated by the impinging light energy would recombine with stray electrons before being collected by the collector. This electrode is biased negatively, as indicated by the simple phototransistor circuit of Fig. 3, so that it will attract the positive "hole" carriers.



SIMPLE PHOTOTRANSISTOR CIRCUIT

FIG. 3

The response curve of the photo-transistor peaks in the infra-red wavelength region (around 1 micron) but also shows satisfactory response in the visible light portion of the spectrum. A unique characteristic of the phototransistor is the small area of its light sensitive surface. Only light falling on that portion of the dimpled germanium pellet immediately under the collector contact will result in an increment in output current. This spot is only .010 inch in diameter. Such localization of the photosensitive region should prove useful in many applications. The response characteristics of a typical phototransistor operating into several different values of load resistance are shown in Fig. 4.

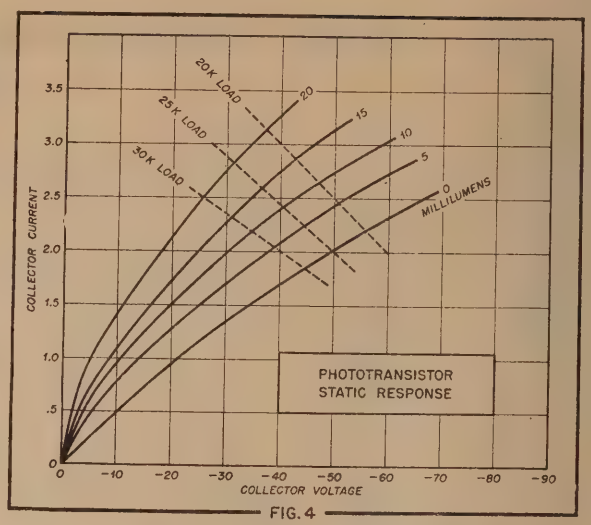
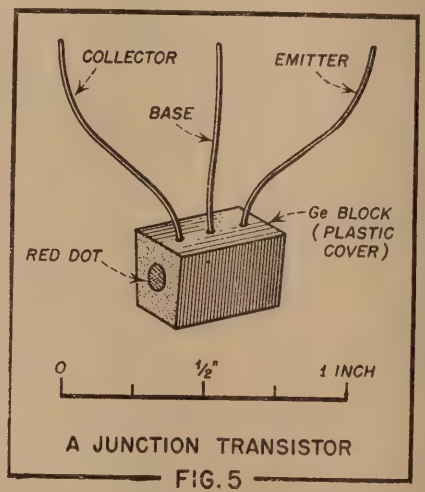


FIG. 4

THE JUNCTION TRANSISTOR

The most significant recent advance in the field of semi-conductor devices was the introduction of the *junction-type* transistor. This new form of semi-conductor triode immediately overcame several of the serious limitations of the point contact type and put the transistor within "striking distance" of many vacuum tube applications which the point contact varieties had fallen short of fulfilling.

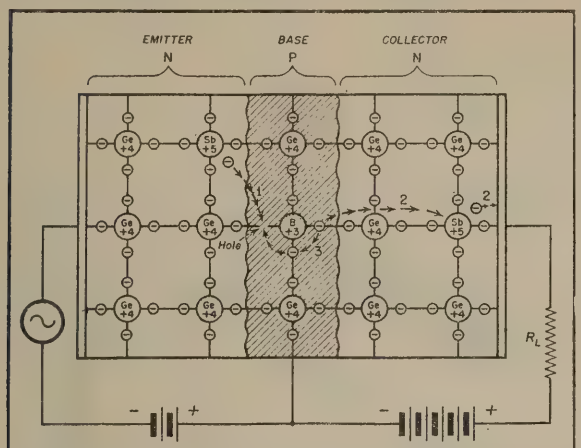


A JUNCTION TRANSISTOR

FIG. 5

The physical appearance of the junction transistor is shown in Fig. 5. It differs from the point contact type in that the rectifying barrier layers are formed by boundaries or junctions between different types of germanium semi-conducting material. The junction transistor is a "sandwich" of a thin layer of *p-type* germanium between two layers of *n-type,* or vice-versa. The three layers must be in very intimate contact; the best results being obtained when all three are formed in a *single crystal* of germanium. Most of the difficulty of fabricating junction type transistors arises in controlling the thickness of these layers, especially the centre (p-type) one which may be only .001 inch thick,

and in attaching wire leads to them. The transistor is called an "n-p-n" junction type if the layers occur in that order, or a "p-n-p" type if the reverse is true. In the n-p-n kind, which we will discuss here, the thin layer of p-type material is considered the "base," while the n-type germanium on either side are designated the "emitter" and the "collector."



ILLUSTRATING ACTION OF JUNCTION TRANSISTOR

FIG. 6

It will be recalled that the difference between n-type and p-type semi-conducting materials results from the nature of the impurities present in the otherwise pure semi-conductor crystal structure. For example, in the case of germanium, if only impurities having five valence electrons are present to form electron-pair bonds with the four valence electrons of the germanium atoms, the result will be *n-type* germaniums since the "left-over" electrons are free *negative* carriers. Such *pentavalent* impurities are antimony, arsenic, and phosphorus. On the other hand, if the impurities present are elements which have only three valence electrons, such as gallium, boron, and aluminium, the resulting semi-conducting is termed *p-type*. This is because the three valence electrons leave defects, or "holes" in the electron-pair bonds with the tetravalent germanium atoms. These "holes" behave like positive charges migrating through the germanium crystal and are attracted to a negative electrode.

It is more difficult to understand the functioning of a junction transistor than the point contact type, since the basic mechanism involved is somewhat more complicated. Some idea of its action can be gained by a careful study of Fig. 6, which shows not only the external circuits involved, but also the highly simplified internal structure of a hypothetical n-p-n junction transistor in which the p-layer is only one germanium atom thick. In this example, one impurity atom of the proper valence is indicated in each of the three layers. In actual practice the ratio may be of the order of one impurity atom for each *ten million* germanium atoms for proper transistor action. Note that the polarities of the applied potentials are opposite to those used with the n-type point contact transistor and are more similar to the connections made in conventional vacuum circuits.

With the circuit connections shown, current flow in the collector circuit depends upon the availability of free electrons from the base, but since this material is p-type, it has no n-carriers to offer. In other words, the collector is biased in the *reverse* direction and the base-collector impedance is very high; it is sometimes as much as 10 megohms. The emitter circuit, on the other hand, is biased in the *forward* direction so that the base must be made only a fraction of a volt positive in order to cause the free electron (in our vastly simplified example) to flow from the n-type emitter material into the base region. How this electron (or one just like it) can diffuse into the collector region may be visualized by assuming that when it flows across the n-p barrier, it fills the "hole" in the boron impurity atom. This "hole" was on the n-p side of the boron atom near the barrier since it was attracted by the negative potential of the emitter and repelled by the collector's positive charge. When the emitter electron fills the defects or "hole," it weakens the hold which the nucleus of the boron atom has on one of the valence electrons on the collector side of the atom since the positive charge of the nucleus is only 3 and it cannot retain more than three electrons effectively. This electron is thus pulled out by the collector potential and flows into the collector which then migrates back to the emitter side of the base and is thus again in position to "ferry" another electron. Thus, for each electron which flows from the emitter to the base, one is freed to flow from the base to the collector. For this reason, the current gain factor, *alpha*, never exceeds unity in a junction transistor. Very high power gains are possible, however, because of the very high ratios of output circuit to input circuit impedance.

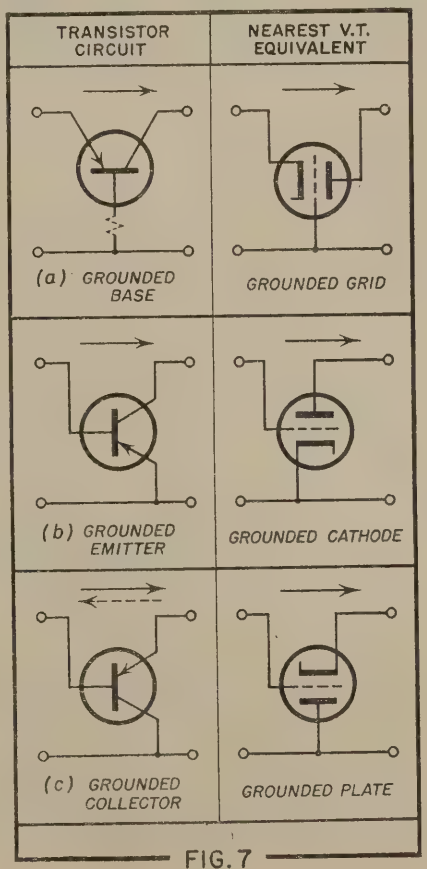


FIG. 7

The outstanding characteristics of the junction transistors are low noise figure, higher efficiency, higher gain, and improved power handling capabilities. Its most unique feature is its ability to operate with good efficiency at extremely low power levels—in some cases as low as a few tenths of a microwatt. The frequency limitations of the junction transistor may be more severe because of the increased capacitance of the bulk-type junctions.

TRANSISTOR CIRCUITRY

The three possible ways a transistor can be connected to function as an amplifier are compared with their nearest vacuum tube analogs in Fig. 7. The transistor symbol used here has been adopted to represent transistors of both the point contact and junction varieties. The emitter is distinguished by an arrow head and the base is represented by a straight line.

Each of the three basic transistor circuits, like its vacuum tube counterpart, has certain characteristics not exhibited by the other two. These may be summarized briefly as follows:—

(a) *The Grounded Base Circuit* compares most favourably with the grounded grid triode tube circuit since the input impedance is low, the output impedance is high, and there is no phase reversal through the amplifier. Typical input-output impedance ratios in this circuit would be 400 : 20,000 ohms for the point contact transistor and about 100 : 10,000,000 ohms for the junction type. Power gains are moderate; about 16–18 db. for the Type A and 50 db. for the junction variety. The operating stability of the grounded base circuit is limited by the *base resistance,* indicated schematically in Fig. 7A by dotted lines. Current flowing through the resistance of the germanium base material produces a regenerative feed-back voltage which can cause oscillation at high gain.

(b) *The Grounded Emitter Circuit* is closely analogous to the triode grounded cathode circuit. The impedance is higher than in the grounded base circuit, and the output impedance is lower. Typical values of input impedance are 1000 ohms for the junction unit and about 2000 ohms for point contacts. The output impedances are about 1 megohm and 10,000 ohms respectively. A phase reversal does take place between input and output, as in the corresponding triode circuit. Higher power gains are obtained in the grounded emitter circuit, being about 23 db. for the point contact transistor connected in this manner and in excess of 50 db. for the junction type. Circuit stability is somewhat worse than in the grounded base circuit since the common feed-back element is now the emitter resistance instead of the base resistance. In point contact circuits, the current gain (*alpha*) must sometimes be reduced to near unity to prevent oscillation. This is not necessary in the junction type unit, since the current gain is inherently less than unity. Noise and power handling characteristics are similar to those of the grounded base circuit.

(c) *The Grounded Collector Circuit* has properties siimlar to the grounded plate "cathode follower" triode circuit. No phase reversal takes place and the output impedance is considerably lower than the input impedance. Input and output impedances are interdependent. Input impedance for the point contact case may be on the order of 40,000 ohms with a corresponding output value of 5,000–10,000 ohms. The step-down ratio for the junction transistor may be even greater—4,500 ohms to as low as 25–30 being possible. As in the cathode

(Continued on Page 36.)

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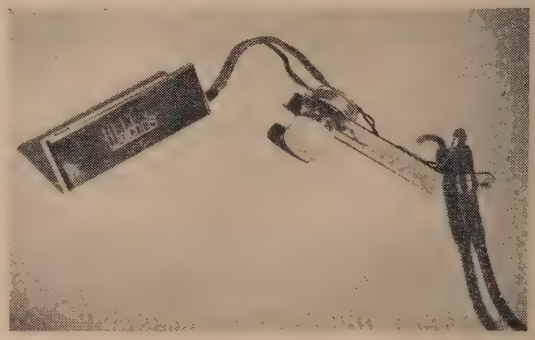

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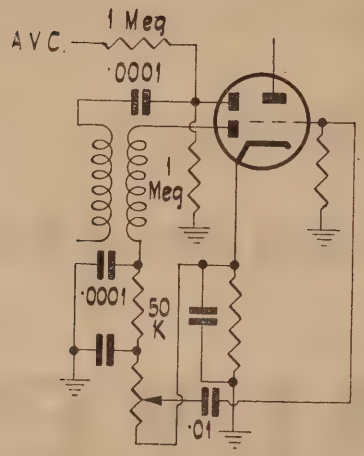


Fig. 1

Most people who dabble in radio, both professional and amateur, and even those who try to make a living out of it, will at some time or other have come across the set which has quite a noticeable amount of output with the volume control shut right off. Recently one such set came to our notice suffering from just this trouble although the harassed owner of the radio didn't quite explain the trouble that way. His story was that with the aerial connected the set distorted badly on local stations although it was fair enough on more distant stations. The most immediate and obvious thought was that A.V.C. trouble was the cause; not without some qualms too, for A.V.C. troubles can very often be heart-breakers.

However, a few quick measurements on the service bench with a signal generator and a sensitive meter on the A.V.C. line soon showed that there was no trouble in this direction. Developed A.V.C. voltage was adequate at very strong carrier levels and followed a normal variation with lesser amounts of R.F. input.

At this stage it was decided to just have a quiet listen to the reproduction from the local stations and not jump to any conclusions unnecessarily. Strangely enough though distortion didn't seem evident—or was it! You get into that frame of mind where you can convince yourself that a set either has got distortion or it hasn't just by willing it so. However, our client had complained so nothing must be left to chance. This particular radio had a four-position switched tone control of quite elaborate proportions and this assembly came under a cloud for no real reason at all. Checking the assembly through brought to light a misplaced condenser which, when corrected, altered the tonal balance a little but otherwise did not materially affect the reproduction.

The next step was to modulate the signal generator from the audio oscillator and examine the waveform of the receiver output on the oscilloscope. Widely differing frequencies in the audio range seemed to have no effect on the set beyond what might be expected due to normal superhet selectivity in the I.F., and quite large R.F. inputs caused no undue distress. Now it must be remembered that a radio operated in the average quiet suburban home runs at a very different sound level from that

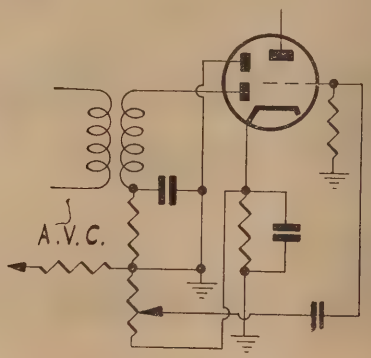


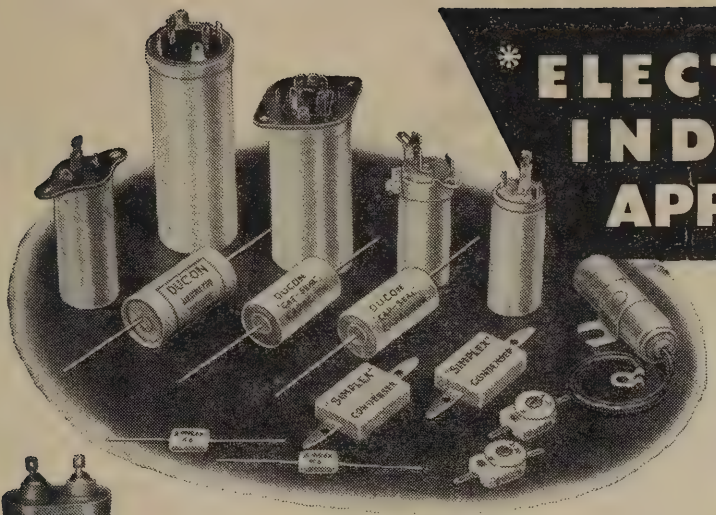
Fig. 2

which is normally the case in a noisy city workshop and this was the crux of the trouble. When the volume control was turned off quite an appreciable amount of sound was still being pumped through, particularly with an aerial connected, and this sound was most definitely distorted.

Here was something tangible at last, and remembering an article read in the dim distant past on this subject the second detector was rearranged slightly. Where a duo-diode-triode is used as second detector, A.V.C., and first audio amplifier, this trouble is often present due to stray coupling between the diodes and first audio section of the valve, also to a large extent by the capacity of the valve socket itself between adjacent pins.

In the set in question, the second detector arrangement was as shown in Fig. 1. The rearrangement is shown in Fig. 2 with the set converted to simple A.V.C. and the odd diode earthed, this particular diode being the one between the signal diode and the triode grid, thus further minimizing coupling. This system worked like a charm and the volume control could now be shut right down without any unpleasant by-products.

The set was buttoned up and delivered back to the customer where a few tacit inquiries from the lady of the house enlightened us to the effect that the set was never turned up loud—always low! Obviously, for some months they had been listening to radio break-through. For the person building a new set who wishes to avoid this complaint, a more complete cure is to use a diode pentode with the pentode section as the I.F. amplifier and then to use a separate first audio tube. This is pretty foolproof and should give excellent results.



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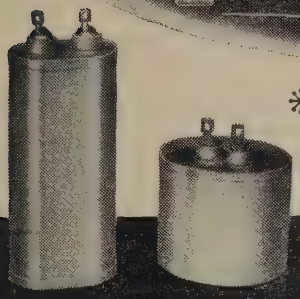

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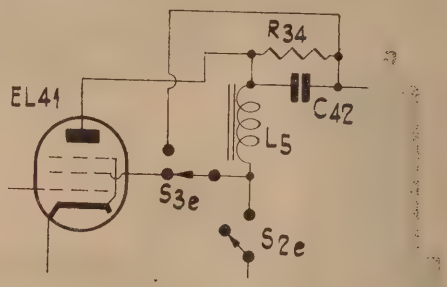
THE B.F.O. AND MODULATION CIRCUITS

So far we have described the alignment of the receiver in some detail, and, to complete the description of the receiver, it only remains to say something about the B.F.O. circuit.

First of all, we should point out an error in the circuit diagram of the receiver, which was given in Part III of this series. S_3, it will be remembered, is the Phone/C.W. switch, and S_{3b} is the section which changes the bias circuit for the controlled stages from A.V.C. on 'phone, to the manual control for C.W. The wiring on the diagram is quite correct, except that S_{3b} is shown in the C.W. position, while the remaining sections of S_3 are shown in the 'phone position. Also, the original diagram showed five sections in S_3. There was no error entailed in this, but some builders may have difficulty in obtaining a five-position switch. The diagram on this page shows how the switching may be modified so as to use only four sections for S_3. In the original diagram, S_{3d} short-circuits the modulation choke on the C.W. position, allowing the full H.T. voltage to be applied to the final amplifier, while S_{3e} removes the screen voltage from the EL41 modulator on the C.W. position. The change consists simply in omitting S_{3d}, and taking a lead from the far end of R_{34} to the htiherto unused contact of S_{3e}. This enables S_{3e} to do both jobs simultaneously, so that the switch now needs only four change-over sections.

The B.F.O. circuit, as drawn, is also not quite correct, as its grid condenser was inadvertently omitted. This should be placed between the tuned circuit and the grid in the ordinary way. It has a value of 50 $\mu\mu$f. The main tuning condenser, C_{36}, is fixed in value, and since the printing of the circuit diagram, has been modified. Originally, it was specified as a 100 $\mu\mu$f. condenser. With that arrangement, the circuit will oscillate, obtaining its feedback from the inter-electrode capacities of the valve. It is preferable, however, to turn the circuit into a true Colpitts, by making C_{36} two 250 $\mu\mu$f. condensers in series, with the junction earthed. If it is desired to use a panel control condenser which has one side earthed in order to facilitate mounting, C_{35} can be connected from grid to earth, or from the tuned circuit to earth, which ever is preferred. In either case, the range of frequency adjustment will be about right. The coil used by us for the B.F.O. was one from an old permeability-tuned 455 kc/sec. I.F. transformer. It was removed from the can, together with its tuning slug, and the latter was used for the initial frequency adjustment. The slug is adjusted with C_{35} at its central position, until the oscillator frequency is exactly 455 kc/sec. After that, it will be found that there is enough range of adjustment on the variable to give all the pitch control that is required.



The coupling condenser, C_{28}, is one that probably cannot be specified accurately in advance, because the exact layout of the parts of the B.F.O. and the I.F. amplifier will determine just how much stray coupling exists between the oscillator and the second detector. In our case it was found that 25 $\mu\mu$f. gave just the right amount of injection, and that the amount of stray coupling was very small. The value of C_{28} is worth experimenting with in order to get it just right, but values between 15 and 50 $\mu\mu$f. should give the necessary range of adjustment.

AUDIO AND MODULATION CIRCUITS

No difficulty at all was experienced with the audio and modulation circuits, which behaved perfectly from the first. The gain is just right for a diaphragm type crystal microphone, and no instabiltiy was found, as might have been predicted on account of the compact nature of the circuit, and the unavoidably long leads to and from the switches.

The dropping resistor, R_{34}, was fixed at 600 ohms, and at that figure, enabled 90 per cent. modulation to be obtained with very little distortion. The modulation choke finally used was one from the ZC1 spares list. It is NOT the modulation choke in the ZC1 that is used, but the smoothing choke, and it can be identified by the words "Part No. T119" written on the back. Together with the 2 μf. condenser, C_{42}, which bypasses the dropping resistor, this gives a reduced low frequency response that is excellent for speech without making it sound thin. It is remarkable how quickly the filament of the final heats up when the transmit/receive switch is thrown to "Transmit." It is only necessary to count "One, two" before speaking into the microphone, to ensure that the beginning of the first word is not clipped off. Since the station has been completed, tests have shown that, as originally expected, the ease of operation is all that could be desired. Once the transmitter is tuned to frequency, and the aerial loaded up, operating consists of nothing more

than throwing the transmit/receive switch at the appropriate moments, and saying one's piece, or, if you prefer it, pounding it out on the key! However, before we leave the station altogether, readers would probably appreciate some discussion of the power supplies that could be used, and of possible aerials to use it with.

POWER SUPPLY

For a start, let us give everyone a pleasant surprise by detailing the H.T. and L.T. current and voltage requirements.

For the heaters, which are left running continuously while the station is operating (except, of course, for the quick-heating filament of the QQE04/15) we need 2.025 amps at 6 volts, while the QQC04/15 takes 0.68 amps, but only while it is working.

For the H.T., which is 250 volts for both transmitter and receiver, the currents required are as follows:—

Receive	35 ma.
Transmit (C.W.)	85 ma.
Transmit (phone)	105 ma.

A power supply rated at 100 ma., 250 volts would be ample. For emergency use in the shack, such a supply would present no problems, and it would be a very good plan to build such a power pack, so that the mobile station can be used should anything happen to either the main transmitter or receiver. For use in real emergencies, however, it will be necessary to have a power pack which does not depend on the A.C. mains, and for this there are two alternatives. An excellent solution, if a suitable one can be found, is a motor-generator rated to give the required current and voltage. Such generators are not uncommon, the main difficulty about them being that they are often arranged for a 24 or 28 volt D.C. input. Either 6 or 12-volt input would be much better, with the 6-volt version to be preferred, though this will certainly be the most difficult type to come by. For a 12-volt generator, it would be possible to run the filaments off half the L.T. battery, but it would be preferable to re-arrange the heater wiring into two 6-volt groups of nearly equal current drain, connecting each across half the 12-volt battery.

Failing a suitable motor-generator, it would be perfectly feasible to use a vibrator supply, operated by a 6-volt accumulator. Suitable transformers and vibrators can be purchased, and the power supply built up, or one can have them made up by firms who specialize in such things. Either way, the requirements are not difficult to satisfy, since an ordinary receiving vibrator is quite capable of delivering the 100 ma. needed.

AERIALS FOR THE MOBILE STATION

For a mobile or transportable station such as this one, flexibility in the possible aerial arrangements is essential. It was for this reason that the pi-section output coupler was decided upon for the transmitter. While it is true that it is not possible to feed a balanced aerial, which requires some sort of two-wire feeder, using this arrangement, this was not felt to be such a disadvantage. In general, the station will have to put up with the most primitive of aerial systems, usually consisting of a single wire of any convenient length. For feeding an aerial of this sort, the pi-coupler is the most efficient means yet devised. Its main advantage is that it will feed power into almost any length of wire, and will allow the final amplifier to be loaded properly. It will NOT make an efficient radiator out of an inefficient one, but it will allow it to load the transmitter. The reason for this is that a wire of any length, arranged in any possible way with respect to the ground, is liable to have any sort of input impedance, from several thousand ohms to only a few ohms. It is also liable to possess any amount of reactance, of either sign, and the great virtue of the pi-section coupler is that it will do two jobs at the same time. It will tune out the reactance of the aerial, and it will supply power to the resistive portion of its input impedance. Looking back at the parts of this series in which the transmitter circuits were featured, it will be found that the condenser nearest the plate of the final is 150 $\mu\mu$f., while the one at the aerial end of the tuning inductor is 500 $\mu\mu$f. Now when we tune the final, we have to do two things. First of all, to tune the circuit to resonance at the operating frequency, and secondly, to match the load to the tube. The burning question of course is, how can we be sure of doing this? The output circuit can be tuned to resonance even with no load at all connected to the output terminal, and it is obvious that in this condition there is no matching taking place.

Well, the job is made particularly easy by virtue of the fact that when a match is obtained between the load and the final amplifier, the R.F. current in the load will be a maximum. Thus, as long as we have some sort of an indicator which will tell us whether our adjustments are giving us more or less aerial current, it will be possible to adjust the output circuit for correct tuning and matching. This is one case where a plate milliammeter, as an indicator of correct loading is not very helpful, which is why we have not provided a jack for measuring the plate current of the final.

The best form of aerial current indicator is a thermocouple ammeter or milliammeter. At one time, these used to be very expensive items, and were consequently not often to be found round the "ham" shack, but since some excellent Weston 0–100 ma. thermo-meters have been available on the surplus market for a considerable period at a fraction of their normal cost, there is little excuse for this now. One difficulty is that until we actually try, we have no means of telling what sort of aerial current to expect. This is only because with our random piece of wire for an aerial, we do not know what its impedance will be at the end where we propose to feed it, and therefore cannot even guess at the R.F. current there will be. For example, if the aerial should be a quarter wavelength long, or shorter, it is likely to have quite a low impedance, whereas if it is nearer half a wavelength long, the impedance will be high. In the first case, the aerial current for a given amount of power will be high, while in the second, it will be low. It is for just this reason that the aerial current is no indication at all of the absolute amount of power that is being fed to the aerial. However, with a given aerial, the amount of current at the feed end does indicate relative power output, since while adjustment is going on, the aerial itself remains unchanged. Consequently, whatever its impedance may be, more current means more power dissipated in it, and vice versa.

Practically, the effect mentioned above means that we do not know whether we will need a milliammeter or an ammeter to measure the relative aerial current. The difficulty can be overcome however, by using a 0–100 ma. R.F. meter, and shunting it by means of a piece of wire should it show signs of going off scale. The power it draws when connected in this way is entirely negligible, and it can be left permanently in circuit if desired. Suppose, for example that the aerial has an impedance of 1000 ohms. If we are to dissipate 10 watts in it, this will mean an aerial current at the feed point of exactly

(Continued on Page 48.)

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AERIALS AND TRANSMISSION LINES

TV antennas rust enough in one year to cut the signal down considerably. The article describes the maintenance to keep outdoor aerials in good condition.

—*Radio and Television News* (U.S.A.), March, 1953. p. 39.

A quarter-wave section of transmission line has impedance transforming properties which are very convenient and simple to apply. A method is given of finding the required impedance of a quarter-wave transformer of "Q" section for matching between two given impedances.

—*QST* (U.S.A.), March, 1953, p. 32.

AUDIO EQUIPMENT AND DESIGN

Articles mentioned in the last edition of this publication dealt with binaural sound reproduction. This paper deals with details of the apparatus. The development of tape recording provides an almost ideal medium for multiple channel recording. It is necessary for the recording head to be duplicated. Details of the instruments, amplifiers, etc., are given.

—*Radio and Television News* (U.S.A.), March, 1953, p. 71.

CIRCUITS AND CIRCUIT ELEMENTS

Pulse-operated time-bases. It is often necessary to examine the fine details of complicated repetitive electrical signals with the aid of a C.R.T. This is difficult if only a normal time-base is available, and for radar circuits a pulsed time-base is often more suitable. The time-base cicruits are in a stable state for a period until the receipt of the pulse from the transmitter, when they go through the cycle of operation and settle to stability once more.

—*Electronic Engineering* (Eng.), March, 1953, p. 94.

Discrimination of narrow-band frequency modulation provides greater output when accomplished by a modified Foster-Seeley circuit than when a standard discriminator is used. A brief description is given of the Foster-Seeley circuit, with details of the adaption for narrow band F.M.

—*Electronics* (U.S.A.), February, 1953, p. 128.

Mention is made of the terms—"volume control," "attenuator," and "potential divider." Sometimes one wants to control the power going into some kind of impedance, and what one needs is an "attenuator," but the thing may seem complicated. Firstly, the effects of mismatching are outlined with special reference to loudspeakers and transmission lines, and it is shown that the attenuator is necessary when reduction of power and matching are required.

—*Wireless World* (Eng.), March, 1953, p. 131.

Variable time-delay circuits are frequently needed for establishing the coincidence of the sweep and a given signal in high-speed oscillographs. A distributed amplifier is used, but as only a limited number of tubes can be used, the signal pulse is permitted to travel through each delay element several times in order to increase the amount of total time delay.

—*Proceedings of the I.R.E.* (U.S.A.), February, 1953, p. 228.

ELECTRONIC DEVICES

There are two stumbling blocks to radio-controlled models—the complications of the device, and the authority to disturb the ether. The model described is a small boat fitted with a one-tube super-regenerative receiver designed around a miniature gas triode. With the exception of the plate relay all parts are standard. Special attention is given to the rotary stepping switch.

—*Radio and Television News* (U.S.A.), March, 1953, p. 35.

Fun with a home-built electronic organ! Firstly, you build the electronic parts of your organ, and in order that it may have a keyboard, you take the piano to pieces. The heaviest part of the piano is the "harp" comprising the frame and strings, but once that is gone, construction will be easier. The circuitry is given and also tuning charts. Only one contact is needed for each key. There is certainly much fun to be had here.

—*Ibid*, p. 59.

Knowledge of the condition of a baby before birth and during delivery is most important and is mainly assessed by listening to its heart beats. An apparatus was constructed to amplify these sounds, to record them and to demonstrate their visual characteristics on the screen of a C.R.T. A tachyometer indicating beats per minute and a pen recorder were also incorporated.

—*Electronic Engineering* (Eng.), March, 1953, p. 90.

INSTRUMENTS AND TEST GEAR

Describes an instrument in the form of an oscillator filter. One valve is a phase shifter in which an audio frequency within the range of about 100:1 is shifted 180 degrees; the valve is used as an output stage and separate amplifier, and, depending on the connections, the instrument will be an oscillator or rejector at the chosen frequency. The instrument will make an excelent whistle filter, or resonance in radio or gramophone service.

—*Wireless World* (Eng.), March, 1953, p. 129.

For the serious ham and experimenter, an accurate method of frequency measurement is indispensable. The unit described provides a selective output consisting of marker frequencies every 1000 kc/sec., 100 kc/sec., and 10 kc/sec. The crystal chosen is a dual frequency type capable of oscillating at either 100 kc/sec. or 1000 kc/sec., depending upon the inductance switched into the circuit. This oscillator circuit is designed to make the output as rich in harmonics as possible. Modulation of the output is provided.

—*Radio and Television News* (U.S.A.), March, 1953, p. 56.

MATERIALS, VALVES, TRANSISTORS, AND SUBSIDIARY TECHNIQUES

Transistor noise differs from other types such as thermal and shot noise, since the transistor noise power per unit bandwidth is approximately inversely proportional to frequency. Recommendations are made for obtaining the best signal-to-noise ratio in point contact and junction transistor amplifiers. Typical values and curves show how this type of noise figure varies with operating point of transistor and source impedance.

Electronics (U.S.A)., February, 1953, p. 104.

The travelling wave tube is not only here to stay but is at present a factor of consequence in microwave system design. Research has produced a very low noise, low voltage, input-stage amplifier at 3,000 mc/sec. The tube is specially adapted for microwave radio-relay work, and is capable of delivering several watts R.F. output power.

—*Ibid*, p. 130.

This article deals with very interesting facts about the surface properties of germanium in a gaseous ambient at atmospheric pressure. It has been found that the total dipole at the germanium surface can be changed by changing the ambient and further, that by proper control of the ambient the surface can be cycled back and forth between two extremes. Surface changes also take place according to the illumination of the surface. These facts appear very important and suggest great possibilities.

—*The Bell System Technical Journal* (U.S.A.), Jan., 1953. p. 1.

Further to news of transistors, the article refers to practical transistor applications. The concept of complementary symmetry promises to be the basis of an application for transistors. Using this technique, it is possible to split a signal into two out-of-phase signals for push-pull application without the use of transformers. Further applications are: a thirty-six transistor television set built as an experiment, and provides good pictures; automobile radios are being built, also portable radios and flea-power transmitters.

—*Electronics* (U.S.A.), March, 1953, p. 112.

Where information must be recorded at the rate of a microsecond per bit or faster, mechanical storage methods become impractical and are replaced by electronic devices. The storage tube described has a target with an insulating surface on which a charge may be deposited without affecting adjacent or nearby surfaces. The electron beam may be modulated for the storage information, with means for reading out the information contained. The applications include a study of fast transients, improved ppi radar display, frequency conversion computer storage and high-fidelity telephone circuits.

—*Electronics* (U.S.A.), March, 1953, p. 126.

MATHEMATICS

Transistor equations summarize some of the important circuits useful to engineers. All equations are in terms of transistor parameters—grounded base, grounded emitter and grounded collector.

—*Ibid*, p. 156.

The operator "j." Many a student has thought of this in awe, to be spoken of only with the lights turned low and the gramophone playing "The Sorcerer's Apprentice." However, by the guidance of the writer the mystery begins to vanish, and this and the term "complex number" become less complex. This article is a "must" for the student.

—*Wireless World* (Eng.), February, 1953, p. 79.

The paper shows how the exact amplitude and phase-shift characteristics of the Wien bridge may be presented graphically and in a form directly useful for design purposes. Using these curves it will be shown how to determine the amplifier requirements if the all-over performance characteristics are specified.

—*Proceedings of the I.R.E.* (U.S.A.), February, 1953, p. 246.

In radio communication problems involving transmission by means of sky waves reflected from the ionosphere it is often necessary to relate (1) great circle distances between transmitter and receiver; (2) virtual height of reflection; (3) equivalent path distance between transmitter and receiver; (4) angle of departure; and (5) angle of incidence of ionosphere. The paper presents a simple graphical method whereby these

(Continued on Page 48.)

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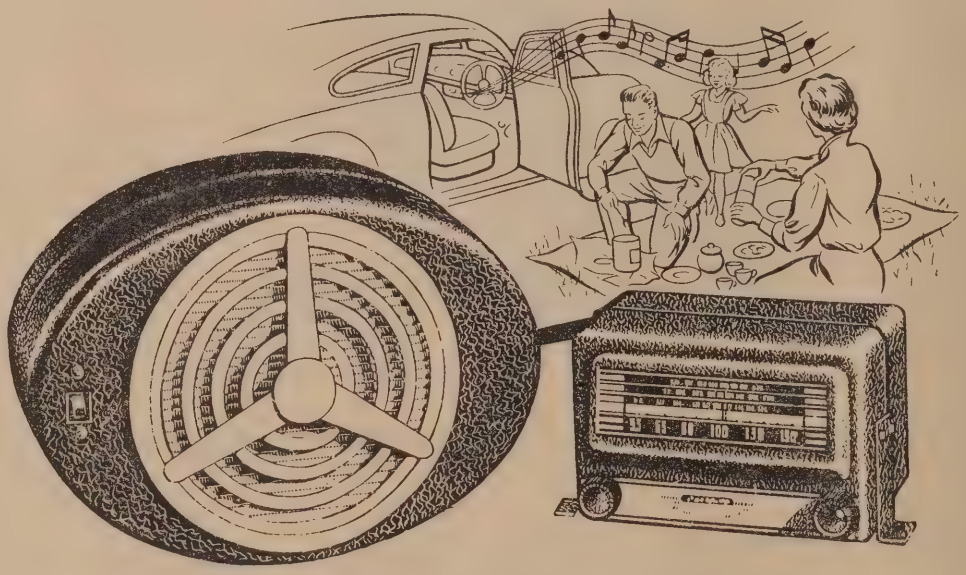

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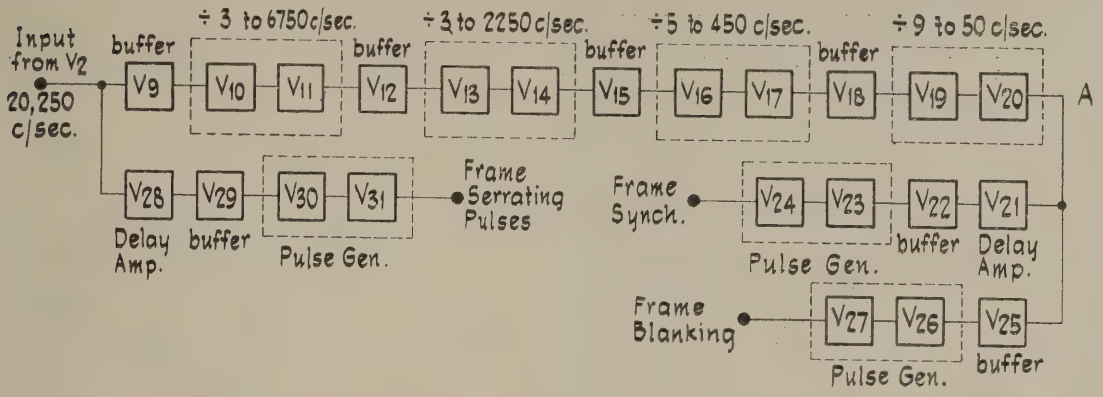


THE FREQUENCY DIVIDER CHAIN

The circuits so far described in this series contain the master oscillator, at twice line-frequency, a divider dividing this frequency by two to obtain the line frequency of 10,125 c/sec., and two pulse generators, for producing the two sorts of line-frequency pulses, one for line synchronization, and the other for line blanking. The next job, and a major one at that, is to build the chain of frequency dividers which, starting with the master oscillator frequency as its input, divides this by 405 in order to obtain the frame frequency of 50 c/sec. For this, four stages are used, dividing respectively by 3, 3, 5, and 9. On the block diagram, Fig. 6, and the circuit diagram, Fig. 7, these dividers are shown as V_9 to V_{20}, a total of twelve valves in all.

While the complete circuit of the divider chain does look a bit fearsome, on account of its size, it is really quite a simple arrangement. Each divider uses exactly the same basic circuit as all the others, the only differences being in a few of the resistor and condenser values. Even here, the different stages vary from each other only to the extent of changes in one condenser and two or three resistors. Thus, the size of the circuit is by no means a measure of its complication.

THE BASIC FREQUENCY-DIVIDER CIRCUIT

This comprises V_9, V_{10}, and V_{11}. Of these, V_{11} is a cathode-coupled flip-flop, exactly similar to those already used in the previous circuits. V_9 is a pulse amplifier, whose job is to provide suitably shaped triggering pulses, to ensure not only that the flip-flop triggers when it is required to, but also that it does not trigger back to the stable condition *before* we want it to. The double diode V_{18} this time has both halves used. One is for applying the triggering pulses, just as before, while the other is used to fix rigidly the potential of the grid of the normally-conducting tube of the flip-flop circuit. The purpose of this is to stabilize the duration of the unstable period as far as possible, and thus to help prevent the divider from dividing by any number other than the one required. It is most important, not only that the dividers shall divide by the right number, but also that they should continue to do so without adjustment, under varying conditions of line voltage, when tubes are replaced, and so on. Consequently, the addition of the stabilizing diode, which is accomplished at the cost of only one additional resistor, is well worth while.

THE TRIGGERING CIRCUIT

So far in this circuit, the triggering of the dividers and pulse generators has been done by the simple expedient of passing a square, or nearly square, wave through a short CR or differentiating circuit, and applying the resulting pips to the circuit to be triggered. Sometimes, this procedure is quite satisfactory, and uses up no additional valves or other components at all. Unfortunately, however, it has certain drawbacks, especially in the case of a frequency divider dividing by more than two. If an isolating diode is used, through which to pass the triggering wave, which has the appearance of Fig. 4 (e), the undesired pips are, in theory at least, prevented from reaching the flip-flop circuit. As far as conduction through the diode is concerned, practice agrees with theory in the matter, but if we examine the waveform at the cathode of the triggering diode when a triggering waveform like that of Fig. 4 (e) is used, we find that although the positive pips have been almost entirely suppressed, there is still a trace of them. This trace may amount to no more than a volt or two, compared with the 50 or more of the wanted negative pips, but it is enough to cause trouble. What happens is that these unwanted pips, being in the opposite direction to those which initiate the flip-flop action, are able to trigger the circuit back to the stable state again. This is definitely undesirable, because the circuit's action as a frequency divider depends on its returning to the stable state in its own good time, as determined by the time-constant of the grid circuit of the right-hand triode, and NOT when triggered by some

external agency. When the flip-flop is in the unstable state, after having been triggered, the state of affairs is that the left-hand valve is temporarily conducting, while the right-hand one is temporarily cut off. Now a positive pip applied to the plate of the left-hand triode also appears at the grid of the right-hand one, having been passed on by the coupling condenser. Should the pip arrive at a time when the right-hand triode is just about to start conducting, it can easily be triggered back by the pip instead of completing the cycle on its own. If this happens, the pip obviously determines the length of the conducting period of the left-hand half of the tube, and (which is the same thing) the length of the non-conducting period of the right-hand half. It is then impossible for this period to last longer than the time from the moment of triggering, to the moment when the unwanted pip triggers the circuit back.

It is to avoid this sort of behaviour that we use, not just a simple differentiating circuit, but one in conjunction with a valve. What actually takes place is shown in the waveforms of Fig. 8. At (a) we have the output of the master oscillator. At (b) is the output of the differentiating circuit, which is applied to the grid of V_9. It will be noticed that the resistor of the differentiating circuit is used at the same time as the grid leak for V_9. This valve is biased by means of a voltage divider which holds the cathode at a fixed potential of approximately 25 volts positive with respect to earth, and therefore with respect to the grid. It is therefore cut off except when a positive pulse is amplified, and appears at the plate of V_9 as a much larger negative-going pulse. The negative-going input pulses, which are not required, are not reproduced in the plate circuit, because the valve is cut off when they arrive, so that all they do is to drive the grid further beyond cut-off. The waveform at the plate of V_9 is shown in Fig. 8 (c). This is transferred to the flip-flop through the diode $V_{10(a)}$. The unwanted pulses, which would be positive in the plate circuit of V_9 are completely suppressed, and can cause no trouble.

The triggering circuit of V_{11} is slightly different from those used previously. The cathode of the diode V_{10a}, instead of being returned to the H.T. line directly, is connected to a voltage divider, at a point whose potential is approximately 100 volts lower than that of the H.T. line. Current flows through the diode from the plate load resistor, and thence to earth through the lower half of the voltage divider. On account of this current, the plate of the left-hand half of the double triode is held at approximately the potential of the tap on the voltage divider. Without the current through the diode, the potential of the plate of the triode would be that of the H.T. line, but as it is, the plate voltage is only about 150 volts, so that the valve is more easily cut off by the current flowing through the cathode resistor from the right-hand triode.

At the same time, this method of connecting the normally cut-off triode stabilizes the amount by which the potential of the grid of the normally conducting triode drops when the circuit is triggered. This also helps to stabilize the duration of the unstable period, and prevent wrong division ratios from occurring.

On triggering, the well-known switching action occurs, turning the left-hand half of V_{11} on and the right-hand half off. This produces a positive-going voltage jump at the plate of the latter valve. Then, after the recovery period, whose duration is mainly

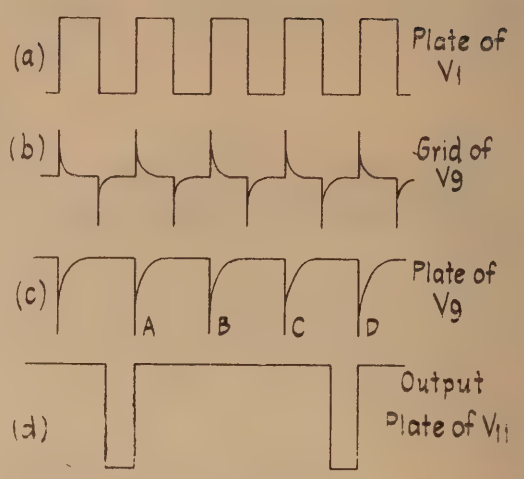
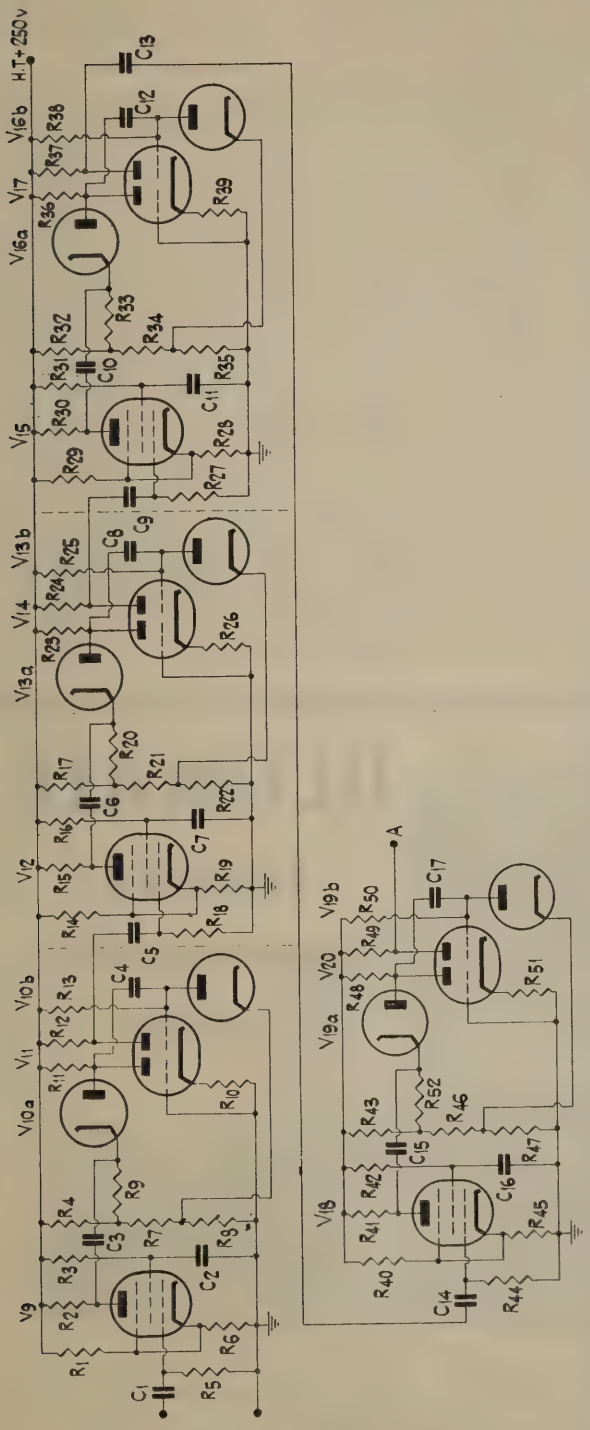


Fig. 8

determined by R_{13} and C_4, the reverse switching action takes place, and the circuit is ready to be triggered by the next pulse. In the meantime, however, two pulses have been skipped over, so that after the one which initially triggered the circuit, the third triggers it again. This means that the circuit is dividing by three.

The remaining nine valves do exactly the same job as the three we have just described. C_5 and R_{14} form another differentiating circuit, applying positive and negative pips to the grid of V_{12}, which removes the negative ones, and turns the positive ones into amplified negative-going ones, just as does V_9. The flip-flop circuit is identical save for the alteration in the size of the coupling condenser between the two triodes. Indeed, the only difference between the second divider stage and the first is that the former has to have an unstable period approximately three times as long as that of the latter, since it has to divide by three from the first stage's output frequency of 6750 c/sec. In this connection, it will be noted that C_8 is roughly three times as big as C_4, while R_{13} and R_{25} are both of the same value.

When we come to the third divider stage, we have the same thing all over again, except that this time the circuit has to divide by five. In order to keep the condensers as small as possible, the grid leak R_{38} is raised to 4 megs. so that the timing condenser C_8 is only 250 $\mu\mu$f. instead of 350 $\mu\mu$f., as would otherwise be required. This process is continued in the fourth stage, which divides by nine times. It is given a grid leak of 8 megs. so as to reduce the value of C_{12} to 0.00125 μf. from the 0.0035 μf. that would be needed if the 3 meg. value were retained. One of the main reasons for increasing the grid leaks in this way is to ensure that the voltage jumps remain as rapid as possible, so that no noticeable time delays occur as we go through the divider chain. The dividers are all triggered at the same time as the negative jump occurs at the plate of V_2 in the master oscillator circuit, and in order to prevent complication, we want the inevitable time delays that occur when one divider is triggered from the previous one, to be as short as possible. The total delay through the whole chain has



thus been kept down to a small fraction of a microsecond.

SETTING UP THE DIVIDERS

The process of setting up the dividers so that their division ratios are all correct is not at all a difficult matter. The simplest way of doing it is to have leads which can be taken to any part of the circuit, and which go to the two vertical deflecting plates of the oscilloscope. One lead is taken to the output terminal of the divider to be set up, and the other to the triggering voltage for the same stage. A lead is also taken to the scope's synch. terminal from the triggering voltage. For example, to set up the first divider stage, one Y-plate and the synch. lead are attached to the plate of V_9, while the other Y plate is attached to the plate of the right-hand half of V_{11}. It must be remembered that when this is done, one of the waveforms on the screen will be shown upside down, but for the purpose we have in mind, this does not matter very much, as long as the fact is remembered. It is best to arrange things so that the output waveform of the flip-flop is shown the right way up, with the synchronizing pips upside down. First of all, the time-base of the oscilloscope is controlled so that three of the input pulses are shown on the screen. For this purpose, it is essential that the flyback of the trace be visible. Otherwise, one of the pips might be missed, and the setting-up procedure to be followed would then result in the wrong division ratio being obtained. Since the time-base is locked by the synch. pips, and since the flip-flop is also triggered by them, both waveforms must be stationary on the screen. It is best, while setting the time-base, to take off the connection to the 'scope from the output of the flip-flop, so as not to confuse the picture for a start. When the time-base is set, attach the other Y plate, and examine the picture. If the flip-flop is being triggered correctly, only one cycle of the output square-wave will appear on the screen, but if the division ratio is not correct, then more or fewer can show. For the correct ratio, the picture should resemble Fig. 9. Here, it can be seen that the triggering pip A triggers the flip-flop so that the right-hand triode is

COMPONENT LIST

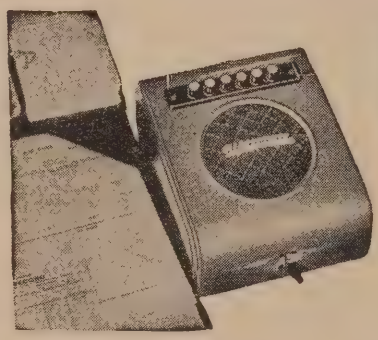
R_1, R_{14}, R_{29}, R_{40}, 50k.
R_2, R_4, R_{15}, R_{17}, R_{30}, R_{32}, R_{41}, R_{43}, 10k.
R_3, R_9, R_{11}, R_{16}, R_{20}, R_{23}, R_{31}, R_{33}, R_{36}, R_{42}, R_{48}, R_{52}, 100k.
R_5, 20k.
R_6, R_{12}, R_{19}, R_{24}, R_{28}, R_{37}, R_{45}, R_{49}, 5k.
R_7, R_{18}, R_{21}, R_{27}, R_{34}, R_{44}, R_{46}, 33k.
R_8, R_{22}, R_{35}, R_{47}, 2k.
R_{10}, R_{26}, R_{39}, R_{51}, 1k.
R_{13}, R_{25}, 3 megs.
R_{38}, 4 megs.
R_{50}, 8 megs.
C_1, C_5, C_9, 50 $\mu\mu$f.
C_2, C_7, C_{11}, C_{13}, C_{16}, 0.05 μf.
C_3, C_6, C_{10}, C_{15}, 0.01 μf.
C_4, 75 $\mu\mu$f. with 3–30 $\mu\mu$f. trimmer in parallel.
C_8, 250 $\mu\mu$f. with 3–30 $\mu\mu$f. trimmer in parallel.
C_{12}, 0.00125 μf. (0.001 and 250 $\mu\mu$f. in parallel).
C_{17}, 0.005 μf.
V_9, V_{12}, V_{15}, V_{18}, EF91.
V_{10}, V_{13}, V_{16}, V_{19}, 6AL5 or EB91.
V_{11}, V_{14}, V_{17}, V_{20}, 6J6 or ECC91.

cut off, producing a positive voltage jump up to the level of the H.T. voltage. The circuit stays in this condition while two more triggers, B and C, arrive, but are ineffective. Then, between C and D, the recovery of the untriggered state happens, and D triggers the circuit once more. Ideally, the recovery, during which the negative jump occurs at the output terminal, should take place just half way between triggering pulses C and D. This is because various effects can cause the time of the recovery jump to vary slightly either way. It is thus good practice to set it half way between the pips so that it has to drift as far as possible before the circuit slips out, and starts to trigger on a wrong pip, making it divide either by two or four, depending on which way the drift has occurred. Because of possible confusion caused by the presence of the fly-back, it is best if the time-base runs slowly enough to take in three or more cycles of the output frequency. This can be done initially by counting out, say 12 triggering pips, for a stage dividing by three. Should the divider slip to a wrong ratio, the picture will still be a locked one, but if the new division ratio will also divide evenly into the number of synch. pips shown on the screen, the picture will still show clearly what is happening. A little experience with the use of the 'scope on these waveforms will soon familiarize the operator with the look of the pictures to be expected.

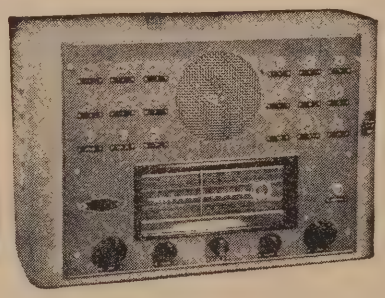
If the division ratio is not correct, the 'scope pattern is used to find out what it is, and this will then show us whether the timing condenser C_4 needs to be made smaller or larger. If it is dividing by two instead of three, the condenser will have to be increased, and vice versa if it is dividing by four. However, on the first stage, it is not likely that any great changes will be needed in C_4, since the variable portion is quite a large proportion of the total.

All the other dividers are set up in the same way, successively, for it is clearly impossible to set one up until all those preceding it are functioning correctly. When our own circuit was being built, we fell into a trap that intending builders of the circuit would be well advised to note. We had not been very fussy about the exact frequency of the master oscillator, but had quickly adjusted it, as we thought, to be quite close to the final frequency of 20,250 c/sec. Then, after having to drop the construction for a time in favour of more urgent work, we took it up again and proceeded to build the divider stages. These were adjusted in turn, and were working perfectly, right down to the last. Then came the acid test. This, of course, was to use the 50-cycle mains as a time-base, for displaying the "50-cycle" square wave derived from the master oscillator, in order to see how closely the frequencies coincide. When this was done, it was found that our output frequency was not close to 50 c/sec. at all, but was very close to 66.6 c/sec., exactly 4/3 times the correct frequency! A careful check of the dividers showed that they were not the cause of the trouble, so the only possible cause was in the frequency of the master oscillator. This was checked, and found, sure enough, to be very close to 27,000 c/sec. The frequency was then lowered to the correct value, and the dividers were checked, and found that now their division

(Concluded on Page 48.)



Executive Intercommunicator



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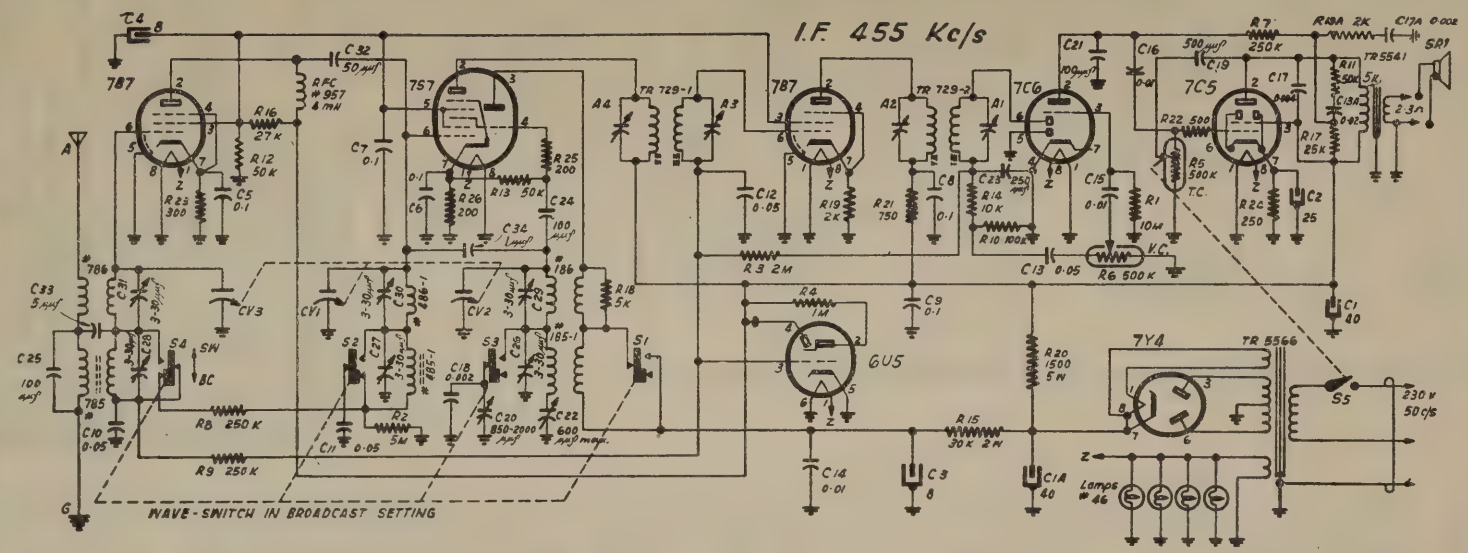


SCHEMATIC DIAGRAM MODEL 729

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	7B7	6.3 AC	240	100	3.2	—	0	3.2	—
Conv.	7S7	6.3 AC	240	162	—5	100	0	2.2	—
I.F.	7B7	—	240	100	6.3	—	0	6.3	6.3 AC
Det-AF.	7C6	—	87	0	—	—	0	—	6.3 AC
Output	7C5	—	218	240	—	0	0	12	6.3 AC
Rect.	7Y4	350	—	310 AC	—	—	310 AC	350	350
Eye	6U5	6.3 AC	15	0	240	—	—	—	—

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	7B7	—	250K	50K	300 ohm	—	1.6 meg	300 ohm	—
Conv.	7S7	—	250K	50K	50K	50K	1.6 meg	200 ohm	—
I.F.	7B7	—	250K	50K	2K	—	1.5 meg	2K	—
Det-AF.	7C6	—	250K	10 meg	—	—	100K	—	—
Output	7C5	—	250K	250K	—	500K	500K	250 ohm	—
Rect.	7Y4	250K	—	28 ohm	—	—	280 ohm	250K	250K
Eye	6U5	—	1.2 meg	1.5 meg	250K	—	—	—	—

1. D.C. voltage measurements are at 2,000 ohm. per volt—A.C. voltage measured at 1,000 ohm per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative. Bandswitch in B.C. position.
4. Nominal Tolerance on component value make possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to the condition of filter capacitors.

Developments in Transistors

(Continued from Page 20.)

follower, the power gain in the grounded collector circuit is low. Figures ranging from 10 to 15 db. have been reported for the point contact transistor, and up to 17 db. for the junction type. A unique property of the grounded collector transistor occurs when the current gain factor is allowed to exceed 1, which is common in Type A units. Under this condition, the amplifier

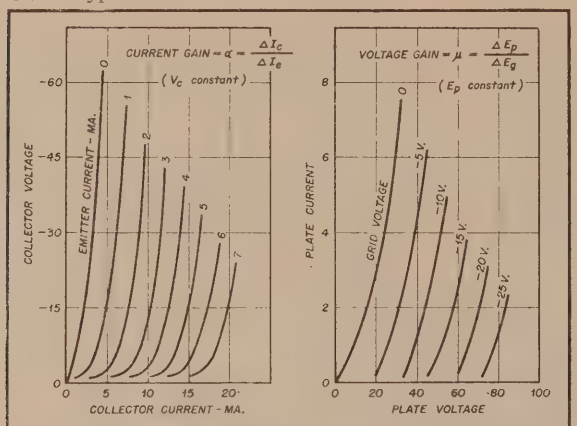


FIG. 8

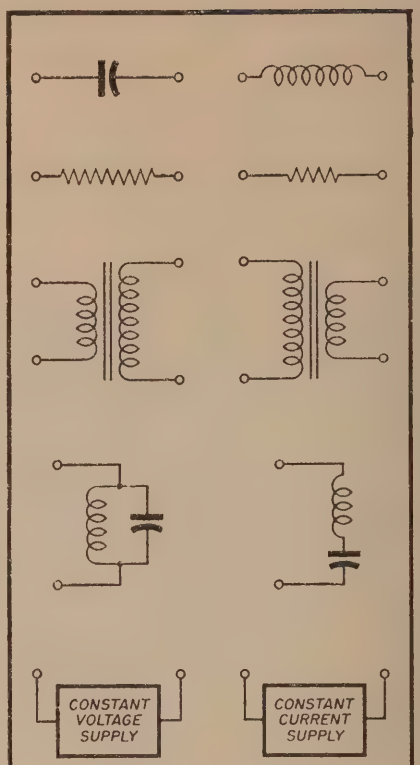
may become *bidirectional,* amplifying signals going in either direction.

THE DUALITY PURPOSE

The most useful tool which has been used in the development of transistor circuits is the principle of *duality.* By the employment of this technique, standard vacuum tube circuits may readily be "extrapolated" to transistor circuits having similar properties.

The basic concept in duality is that the transistor is a current operated device rather than a voltage operated device like the vacuum tube. Therefore, replacing circuit elements having certain voltage characteristics in the standard vacuum tube circuits with elements having similar current characteristics, and vice-versa, will lead to a circuit which functions well, in a surprising number of cases, when a transistor is substituted for the vacuum tube. This interchangeability of voltage and current functions is quite graphically illustrated in Fig. 8, where the static characteristics of the triode tube and the transistor are compared. Note that emitter *current* bias replaces grid *voltage* bias, collector *current* replaces plate *voltage,* and collector *voltage* is interchanged with plate *current.* Note also that the voltage gain factor of the triode (*mu*), the ratio of plate *voltage* change to grid *voltage* change, has been replaced in the transistor characteristic by *alpha,* the ratio of collector *current* change to emitter current change.

Some of the common circuit elements and their corresponding *duals* are compared in Fig. 9. Note that in each the role of current and voltage are interchanged. The dual of a capacitor, for example, in which the *current* is proportional to the time rate of change of the impressed *voltage,* is an inductance, in which the *voltage* drop is proportional to the time rate of change of the *current.* Similarly, the dual of the conventional parallel resonant circuit used for tuning in vacuum



"DUALS" OF SOME COMMON CIRCUIT ELEMENTS

FIG. 9

tube circuits because it develops high impedance and voltage) at resonance, is a series resonant circuit in transistor practice since it exhibits low impedance (passing high current) at resonance. Likewise, the dual of a voltage step-up transformer is a current step-up transformer, as shown.

As an example of the use of the duality technique, suppose that it is necessary to convert the standard tuned-plate, tuned-grid vacuum tube oscillator of Fig. 10A into a transistor oscillator. To do this by duality, the circuit elements of Fig. 10A would be replaced by

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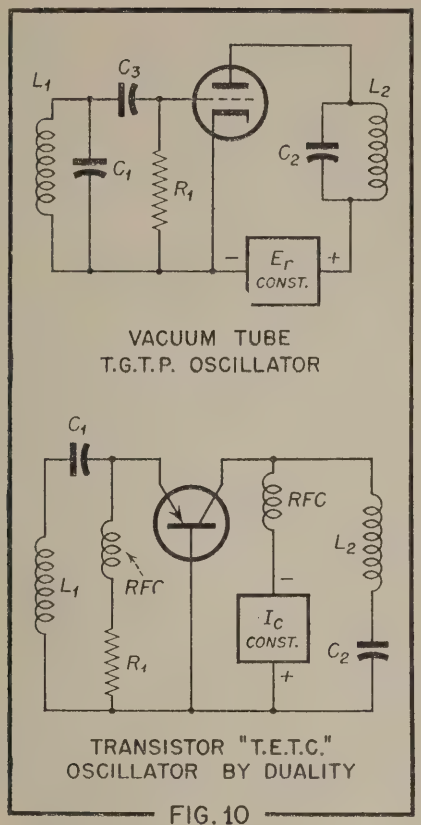

FIG. 10

the corresponding dual circuit elements shown in Fig. 9. The parallel resonant combinations L_1, C_1 and L_2, C_2 are replaced by low impedance series resonant circuits, the D.C. bias blocking capacitor (C_3) is replaced by the R.F. blocking inductance (RFC), the high grid bias resistor (R_1) would be replaced by a low resistance, and the constant plate voltage supply would be replaced by a constant current collector supply. The resultant transistor circuit is shown in Fig. 10B.

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British Radio Component Show

The tenth annual exhibition of the Radio and Electronic Component Manufacturers Federation held at Grosvenor House, Park Lane, London, W.1, from April 14 to 16, was the largest and most comprehensive yet held. In ten years the number of exhibitors (now 120) has doubled and the display area increased sixfold.

Before the war 90 per cent. of the products of the Federation were used in the manufacture of British domestic radio and television receivers. Today, in spite of the expansion of television—each set using something like four times the number of components in a radio receiver—only 40 per cent. of British components are used in this way. Direct export sales of loose components account for 25 per cent. of the production and the rest goes into communication equipment, radar, scientific instruments, medical apparatus, and the steadily increasing electronic equipment in diverse industries.

This exhibition has the virtue of being compact and easy to inspect in full. It attracts up to 20,000 visitors, all technically interested, a large proportion coming from some 30 countries abroad. It is not surprising, therefore, that it is chosen by most British component and valve manufacturers as the exhibition in which to launch any new idea or product. The exhibition, moreover, has a two-way interest for manufacturers—it has become a pleasant annual meeting place for exchange of information between manufacturer and client.

British manufacturers, schooled in the war years to produce components of the very highest reliabiltiy for use in every climate, continue to keep up their standards and it is significant that the industry itself has led the way in the establishment of standard specifications for almost the whole range of components.

These have been published by the Radio Industry Council (representing all sections of the radio industry) at intervals over the past few years.

TRENDS IN VALVES

Among main trends this year are the development of components for the two higher bands in the V.H.F. range and the simplification and miniaturization of components. The two bands for which much commercial equipment will be needed next year and later—the 150 mc/sec. and 400–500 mc/sec. bands—require special valves, coils, resistors, and capacitors for radio frequency stages in the receivers. These and the necessary valve-holders, coil-formers, and other insulating materials were shown.

Radio frequency valves capable of being used as oscillators up to approximately 600 mc/sec. are already obtainable in quantities. These are manufactured in various types with the standard 6.3v. heater and the universal A.C.–D.C. voltages—all of them have the glass base.

Other valves of the disc-seal type for still higher frequencies are also included in most manufacturers' ranges. One interesting valve for use as detector for both frequency modulation or amplitude modulation is a "nonode."

Parallel with the development in valves is that of cathode ray tubes. These vary in size from one only 1 inch square to another 20 in in diameter. The majority of tubes in British TV receivers is still the 12 in. type, but the 14 in. rectangular tube is growing in popularity. There will be special interest this year in the latest examples of germanium crystal diodes as now incorporated in some television receivers.

The incorporation of ion-traps is now almost standard. A necessary accessory to the cathode ray tube—the rubber mask—will be shown for all tube sizes and types by a British firm which manufactures about 90 per cent. of the masks sold in Britain and a large part for the Continental companies.

MAGNETIC MATERIALS

Other accessories to the picture—focusing magnets and deflection coils—are now made with modern magnetic moulded materials, magnadur for the focusing and ferroxcube for deflection. Ferroxcube is now widely used for varying the inductance of coils or transformers and as the core in chokes or transformers. Magnadur takes the place of the normal iron or steel permanent magnet and retains its magnetism despite rough handling and shocks. Both are obtainable in any type of moulding. Several manufacturers showed deflector coils and focusing units to operate with the 9Kv–12Kv high tension voltage applied to the anodes of most of the recent picture tubes.

Tuning and compensating coils were shown by half a dozen companies, while on the radio frequency side double and multiple tuners for covering several channels are available in either turret or pack form. The standard tuner can be switched to five channels but is also made to cover up to seven.

The aerial manufacturers showed improved types of dipole aerials and feeders and alternative models for

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In the field of resistors and capacitors still further advances have been made in miniaturization and reliability. Electrolytic capacitors have been reduced in size by about one-third, while working temperatures are raised to 85° centigrade to 100° in the case of one using tantalum and to 120° in another case.

Some ceramic capacitors work at several thousand volts and are small enough to be used for suppressing electrical equipment like shavers and hair-dryers.

Among the thousands of accessories to the manufacture of radio, television, gramophone, and recording apparatus there are new types of automatic record-changing mechanisms by three firms. All are three-speed models catering for the latest long-playing records. One new type pick-up tracks as low as 20 cycles and with a pre-determined needle-point pressure of 7.5 grams. for all types of record. Another virtue of the pick-up is that it is fully tropicalized by sealing as indeed are most British components.

MICROPHONES

One of the most popular microphones is a ribbon model—a high impedance unit with a response which does not vary more than ±2 db between 50 cycles and 9 kc/sec, Below 50 cycles the characteristic rises, making it particularly suitable for use with high quality amplifiers and tape recorders.

With the increasing market for tape recorders several firms showed multiple-speed motors and recording heads and all the components required for manufacture, as well as the complete desks for use separately or for inclusion in expensive radiograms.

The 300 different items exhibited included miscellaneous materials, components and gadgets like corded solder with a new type of flux, soldering tags, screws, wire and cables of all types, and metal chassis. One interesting small component was a new device to supersede fuses in electric circuits. This is an automatic cut-out which operates as pre-determined currents of as low as 50 ma. It is capable of withstanding overloads up to ten times the normal current and gives a clear indication when it has been operated.

Among the hundreds of fastening devices is a new range of patented self-tapping screws and drivers and a fastener unit in which a pre-assembled lock-washer is trapped under the head and cannot be lost. This simplifies assembly as well as servicing and saves time in all operations.

Several of the loudspeaker manufacturers are concentrating on units for overseas, including a 25 cm. elliptical speaker for domestic purposes, and a 3-watt re-entrant and a large re-entrant horn type.

TEST EQUIPMENT

Comprehensive ranges of specialist test gear were shown by several well-known manufacturers. These consist of signal generators, oscilloscopes, high resistance and electro-static meters for every purpose on the work bench or laboratory, and a portable frequency meter catering for all the likely ranges in the V.H.F. bands. One model covers 125–250 mc/sec. while the highest covers 2000–4000 mc/sec. Another firm showed a very cheap but efficient signal generator for use on the present television band with a range of 100 kc/sec. to 70 mc/sec.

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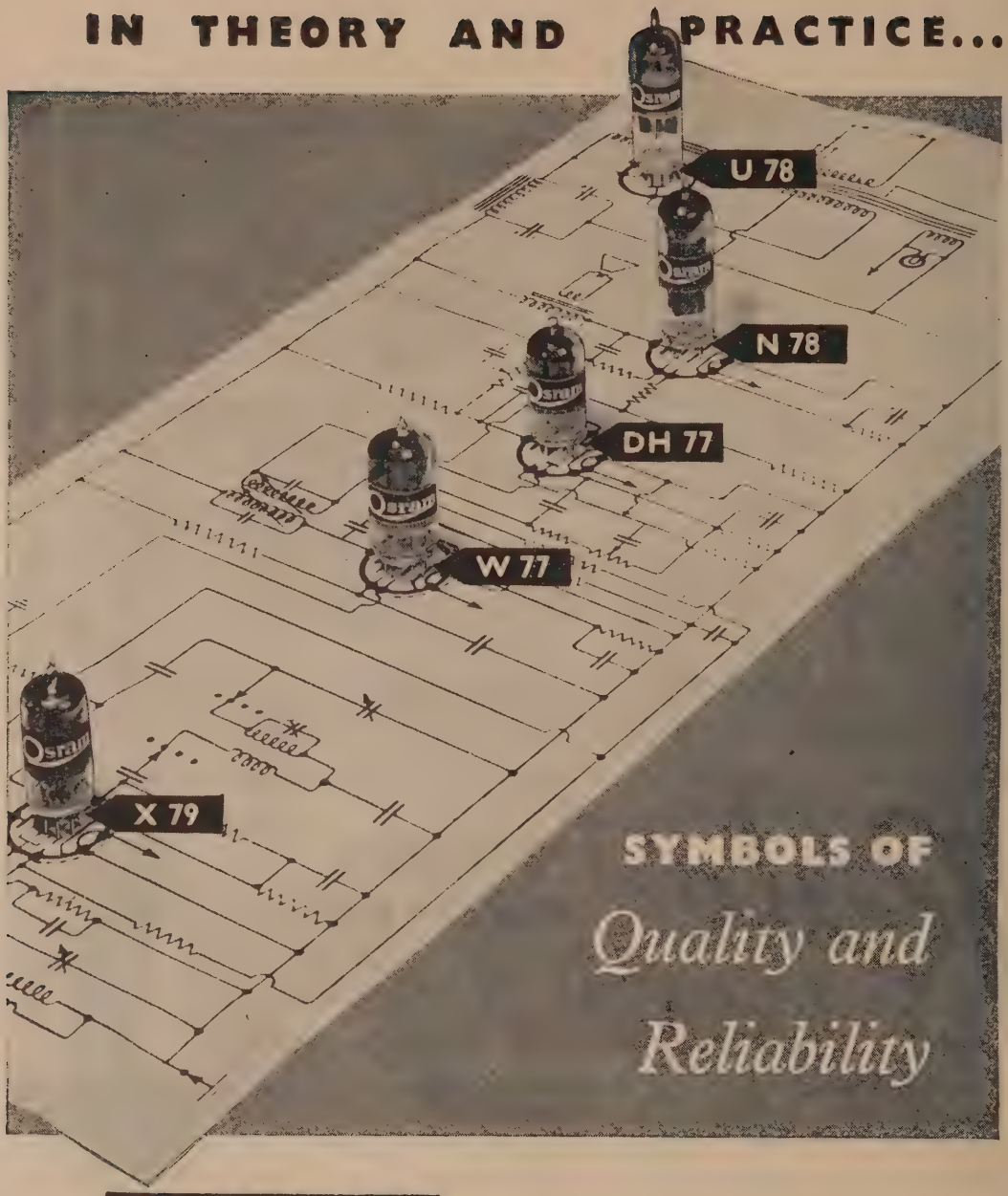

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TRADE WINDS

Mr. A. J. (Jack) Wyness who succeeded Mr. A. Wyness as Managing Director of H.M.V. in 1952 has now been appointed Chairman of Directors of this progressive organization on the relinquishment of this

Mr. A. J. Wyness

position by Mr. Wyness, Sen., the latter having now severed all active connection with H.M.V. (N.Z.) Ltd.

Mr. A. J. Wyness who is well known in business circles throughout New Zealand and Australia has had extensive training for the high position he now occupies, having served for some time with the parent organization in England where he gained first-hand experience in the radio and recording production fields. He has recently returned from Australia where he has been in conference with the company's Australian organization concerning television and it is understood that as a result of this conference the Australian and New Zealand organizations, with the support of their parent company, will, when the time arrives, be fully geared to meet the public demands in their newest radio field.

* * *

Mr. R. B. Pulham, Manager of G. A. Wooller & Co., Ltd., recently visited Australia to arrange supplies.

* * *

BELGIAN AND JAPANESE TELEVISION CONTRACT

Pye Limited of Cambridge, who recently announced a £70,000 television contract with Belgium, announce that in competition with several manufacturers, including a number of American firms, they have secured the substantial Radio Tokyo television contract.

During the next few months, three camera chains and the associated control equipment, all of which will operate on the American TV systems, will be shipped to Japan from Cambridge.

The Belgian contract, mentioned above, consists of the equipment for two complete television studios for the "Institut National Belge de Radio-diffusion" I.N.R.—the Belgian Television Service.

One of the outstanding features of the equipment to be supplied to Belgium is that it will operate on both 819 and 625-line standards. This equipment will be the only one of its kind available anywhere in the world, and it will enable them to link up with either the French or the Dutch TV services, only a simple switch being necessary to change-over any unit from one system to the other.

* * *

CANADIANS ORDER TV TRANSMITTER FOR OTTAWA

The Canadian Broadcasting Corporation has ordered British television transmitting equipment for the Canadian capital, Ottawa. This will be the third station in a network the corporation is planning to build across the country, of which the Toronto and Montreal stations have been working since September.

Ottawa will have a 5-kilowatt vision transmitter and a 3-kilowatt sound transmitter, with all associated monitoring and control equipment.

Although the new station is not due for completion until autumn, C.B.C. has asked that the transmitters be temporarily installed in the existing A.M. sound broadcasting station at Ottawa, so that viewers can see telefilms of the Coronation. This should be done by the middle of May.

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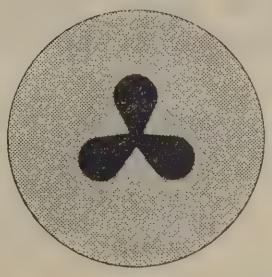

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To do it, Marconi's Wireless Telegraph Co. Ltd., who will supply all the transmitting equipment in association with the Canadian Marconi Company, and who also supplied entire studios and outside broadcasting units for the two existing Canadian stations, will erect a single-stack aerial on the site. This will transmit signals over a range of approximately 15 miles.

When the transmitters are moved to their permanent site, signals will go out from a 12-stack high-gain aerial. This will serve to increase the signal strength to about 55 kilowatts, and the radius of reception is estimated at some 40 miles, though it may be much wider.

Reason for this special aerial is one of economy; it is cheaper to use a lower-powered transmitter with an aerial which steps up signal strength rather than a more powerful transmitter and small aerial.

Ottawa will not have its own television studios but will, instead, transmit programmes sent by link from Montreal and Toronto.

The equipment will be of a standard type similar to that supplied by this company to B.B.C. television transmitting stations, though it will be a 525-line system.

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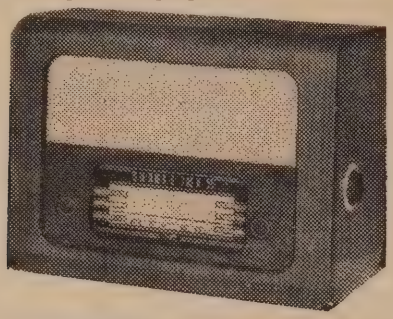
The new "Ultimate" Mantel Model Receiver illustrated here is a contemporary styled cabinet modelled on clean lines and generous proportions.



The "Ultimate" multi-wave receiver has a large flood-lit dial in four colours with an easy to read scale adequately marked with station call-signs.

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* * *

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Messrs. H.M.V. (N.Z.) Ltd., announce the arrival of the E.M.I. Type 17 Transcription Pick-up, the distribution of which is being handled by its trade division, E.M.I. Suppliers, P.O. Box 296, Wellington, to whom all inquiries should be addressed.

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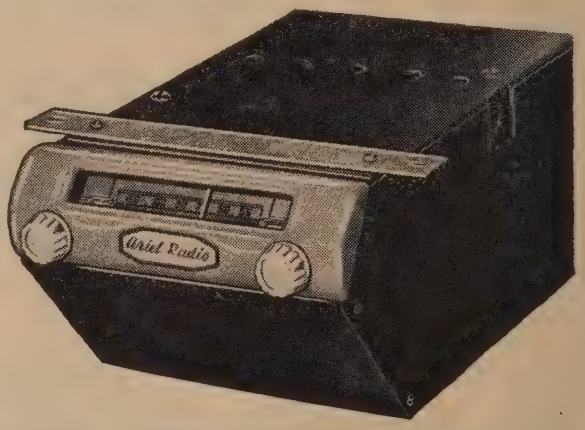

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Proceedings of the New Zealand Electronics Institute Incorporated.

HEADQUARTERS NEWS

The last Council meeting of the Institute's year was held on Wednesday, 27th May. As this issue of *Radio and Electronics* went to press before that date, it has not been possible to include an account of the proceedings in this issue of *Radio and Electronics*. However, the agenda is already to hand, and a number of important matters are to be discussed. Perhaps the most important of these is a report to be submitted by a special subcommittee of Council, set up to investigate the matter of recogntiion by outside bodies of membership qualifications of the Institute. The results of a postal ballot will be scrutinized, on the subject of the continuation of *Radio and Electronics* as the official journal of the Institute. It will be remembered that, as this is a matter which affects all grades of members, while only corporate members are entitled by the consttiution to vote on it, a Gallup poll of the total membership of the Institute was held, to obtain the general feeling, and to act as a guide to corporate members when voting on this important question. The postal ballot referred to is the resulting ballot of corporate members. This will also be the last meeting of the old Council, whose final task will be to make arrangements for the Annual General Meeting of the Institute.

WELLINGTON BRANCH NEWS

The April meeting of the Wellington branch took the form of a visit to the X-ray department of the Wellington Hospital, where members inspected the diagnostic and therapeutic equipment, and had its technicalities described by a member of the hospital's technical staff.

It was surprising to find how complex modern X-ray equipment has become, particularly in view of the extreme simplicity of its basic circuitry and principles. Most of the complication arises through the need for very exact control over the strength, timing, and hardness of the rays used for various purposes. For photographic use, quite different types of ray are used compared with those used for therapy work, and for "screening"—the visual viewing of X-ray patterns with the aid of a fluorescent screen. Very elaborate precautions have to be taken, especially in the therapeutic machines, to prevent all possibility of exposure to the rays by anyone other than the patient, and also for controlling the exact dosage to which the patient is subjected. It is in these controlling functions that most of the electronic equipment is to be found, in spite of the fact that the X-ray tube itself is an electronic device. It was surprising, too, to find somewhat crude electro-mechanical gear used for solving the rather delicate problem of ensuring that mains power is not applied to or removed from the X-ray tube except when the voltage is passing through its zero.

WELLINGTON BRANCH TV PROJECT

By the time this appears in print, the construction of the Branch's television transmitter will have commenced. The best news to date is the advice received from Messrs. H.M.V. (N.Z.) Ltd. that their principals, Messrs. E.M.I., have decided to send to the Branch, on extended loan, two of their latest types of camera tube, the C.P.S. Emitron. These tubes will probably be forwarded by air freight, and should be here very shortly.

It would certainly appear that there is now nothing but the Branch's own working time needed before we have a TV signal on the air, and the Committee hopes to achieve this object by January of next year.

Missing and Stolen Radios

Criminal Investigation Branch, Palmerston North

Autocrat 6-valve B.C./auto radio, serial No. 1408: milk coloured, round plastic front, light brown steel case.

Criminal Investigation Branch, Wellington

H.M.V. auto radio, model 524, serial No. 32577: 12-volt broadcast, in amplifier, speaker, and tuner units, 7 in. x 6 in. x 2 in.; black dial with white letters and figures; five push buttons and two black control knobs on each side of dial. Amplifier in black metal case; licence No. 26122. "Rola" speaker unit 6 in. diameter.

Criminal Investigation Branch, Dunedin

"Courtenay" 6-valve dual-wave, model 166, serial No. 20490. Four adjustable knobs set in medium oak cabinet 24 in. x 12 in. x 10 in.; round dial with narrow pointer travelling full width of dial.

Criminal Investigation Branch, Queen Street Wharf Police Station, Auckland

Mullard" battery/electric portable, Model MAB 1052, serial No. 98916; size 15 in. x 12 in. x 8 in; front, top, and back silver, ends navy blue; two round control knobs; handle on top; rectangular dial.

Police Station Tauranga

"Westco" 4-valve broadcast model A.C. 230 W. Serial No. any one of following, 42439, 38381, 38920, 3836, 7675, 7677, 38932. Maroon plastic cabinet 9 in. x 8 in.

Auckland

H.M.V. "Perth" radio, serial No. 25262, colour brown and white.

"National" radio, serial No. 111/85, colour brown.

Police Station, Wanganui

"Columbus" 5-valve broadcast mantel model, serial No. 04105. Light brown wooden veneer cabinet, fitted with internal loop aerial; vertical dial.

Criminal Investigation Branch, Christchurch

"Aerial," 6-valve broadcast, battery/electric portable, serial No. 901. Red perspex cabinet.

"Motorola" 5-valve auto radio; chassis No. 4225/116657; 15 in. x 9 in. x 9 in.; brown bakelite front, fitted with two cables to separate control panels.

PUBLICATIONS RECEIVED

"Wireless and Electrical Trader," Vol. 9, Nos. 1180 and 1181.

"Service," February, 1953.

"N.Z. Science Review," Vol. 11, Nos. 1 and 2, January and February, 1953.

"Electronic Engineering," March, 1953, Vol. XXV, No. 301.

"A.P.A.E. Journal," March, 1953, Vol. 4/3.

"Westinghouse Engineer," Vol. 13/2, March, 1953. Westinghouse Electric Corporation, Pittsburgh, Pa., U.S.A. (H. W. Clarke (N.Z.), Ltd.)

"Philips Technical Review," Vol. 13, Nos. 11 and 12; N.V. Philips Gloeilampenfabrieken, Eindhoven. (Philips Electrical Industries of N.Z. Ltd.)

"Electron Tubes in Industry" (Henry and Fahnestock). McGraw-Hill Book Co., Inc., New York, U.S.A.

"Principles of Radar" (Reintjes and Coate), 3rd Edition. McGraw-Hill Book Co., Inc., New York, U.S.A.

Radio Industry Council Specification No. RIC/121—Issue No. 1, Sections 1 and 2, Resistors, Rotary, Variable, Wire-wound.

"Technique," Vol. 6/4, October, 1952. Muirhead & Co., Ltd., England. (Richardson McCabe and Co., Ltd., Wellington).

"Radiotronics," Vol. 18/4, April, 1953. Amalgamated Wireless Valve Co. Pty. Ltd., Sydney, Australia.

"Remote Control by Radio," A. H. Bruinsnia, Philips Technical Laboratory, N. V. Philips Gloeilampenfabricken, Eindhoven, Holland.

EXTENSION LOUDSPEAKERS

(Continued from Page 6.)

in parallel require half the load impedance that a single tube does, the transformer obviously needs the same turns ratio as before. The only difficulty may be that the extra H.T. drain of the additional output valve will be too much for the existing power transformer to handle without overheating. The additional power valve could be built as a separate unit, with its own little power supply, and fed with audio input voltage from the grid pin of the original output valve. This would, of course, necessitate a separate output transformer for the extension speaker, but the installation would then have no observable effect on the main set.

CLASSIFIED ADVERTISEMENTS

FOR SALE—Two new ZC1 MK.1 Transceivers, crystal controlled on 2162 and 2182 kc/sec. Marine frequencies. 12-volt operation. Also 2 pairs crystals as above.—Parminter's Radio Service, Wairoa.

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Abstract Service

(Continued from page 27)

factors can be determined rapidly without recourse to analytical expressions.

—*Electronics* (U.S.A.), February, 1953, p. 150.

PROPAGATION

Frequency economy in mobile radio bands: the various factors affecting the usability of mobile radio channels are discussed, and estimates are obtained for all the number of usable channels per megacycle for several present and proposed methods of operation.

—*The Bell System Technical Journal* (U.S.A.)

Intermodulation interference becomes a serious factor in frequency usage when a block of consecutive channels is provided for a given type of radio service in a confined area. Whenever energy at two or more radio frequencies combines in a non-linear circuit, as in transmitter output stages, or in receiver input stages, products at other than the original frequencies are created. The question is dealt with mathematically, and suggestions made for channel selection for the elimination of such interference.

—*Ibid*, p. 69.

RECEIVERS

An all-purpose super-selective I.F. amplifier: this amplifier uses two channels in parallel—a sharp one for C.W. or for phone carrier, and a broad one for a 'phone sideband. The construction is complicated, but the circuit is an interesting one for study.

—*QST* (U.S.A.), March, 1953, p. 23.

TELEVISION

Receiver changes to improve fringe reception; a practical discussion on how to increase TV set sensitivity by making tube A.G.C. and alignment changes.

—*Radio and Television News* (U.S.A.), March, 1953, p. 42.

The spook; Another weird effect to haunt TV. The spook originates as an electro-magnetic radiation from the horizontal deflection circuits of television receivers and is picked up by the sensitive R.F. or I.F. circuits of the receivers. When seen in the picture it appears as a narrow vertical band very close to the left-hand edge of the raster. This type of interference passed unnoticed for a long period, and the study of the elimination is interesting.

—*Ibid*, p. 64.

The noise content of the vision signal in fringe areas degrades the picture in two ways—it superimposes a gain on the actual picture and secondly it mutilates the line sync. pulses, causing the time-base to fire in a random manner. The frequencies of the saw-tooth output and the incoming sync. are compared in a discriminator circuit which provides a control for the saw-tooth generator. Thus the time-base is no longer controlled by each individual pulse, which avoids "jitter" in the fringe areas.

—*Wireless World* (Eng.), March, 1953, p. 137.

Television sound reception: selective circuits are necessary following the sound take-off from the common I.F. to eliminate vision signal break-through, while an adequate bandwidth is desirable to preserve the steep-fronted noise spikes in order that the noise limiting apparatus may be efficient. Cross modulation is also to be avoided. The requirements are discussed and the suggestion made for critical capacitance coupling which provides the required flexibility of adjustment.

—*Electronic Engineering* (Eng.), March, 1953, p. 114.

Philips Experimenter

(Continued from Page 25.)

100 ma., and the meter would just make it. For somewhat lower impedances, the same meter will manage quite well, provided it is shunted so that only a portion of the current flows through it.

AERIAL MATCHING PROCEDURE

The first thing to do is to attach the aerial, with the milliammeter in series with it at the output terminal. The Phone/C.W. switch is turned to "Phone," so as to avoid having to hold the key down, and with the large condenser in the tank circuit set at approximately half capacity, the small one is *slowly* tuned through resonance. We emphasize the slowly, because thermo-meters are rather slow to respond, especially at low scale readings, and it is an easy matter to miss the indication as one tunes through it. The in-tune condition is recognized by maximum reading on the meter, and its value is noted. Then, a fairly large change is made in the setting of the 50 $\mu\mu$f. condenser, and the small one is re-tuned to give maximum reading. The size of the new maximum, compared with the original one will tell whether the change was in the right direction or not, and if several readjustments are then made until a setting of both condensers is found at which the aerial current is greatest, this represents the best matching. Under some conditions, in particular, those where the feed-point impedance of the aerial is very high, it may be that no position can be found for the output condenser, in which a maximum reading occurs. If this is so, it will be because the output condenser has to be turned so far out that it is no longer possible to bring the circuit into tune with the plate condenser. If this state of affairs is found, the solution is to add a little fixed capacity in parallel with the 150 $\mu\mu$f. condenser and try again. If the output is still on the way up when tuning occurs with the plate condenser at maximum, a little more fixed capacity should be added until it is possible to find the absolute maximum aerial current.

Short aerials, such as whips, are likely to have a very low impedance, and it may be found with one of these that even with the output condenser at maximum capacity, a maximum aerial current has not been found. This is a case for adding some fixed capacity in parallel with the output condenser, so that a 500 $\mu\mu$f. fixed condenser will ensure a continuous range of values above the maximum capacity of the variable. For the receiver, no aerial matching arrangements have been made, because the question of matching is much less important than for the transmitter. The receiver is very sensitive, and can be expected to give excellent results even with a short piece of wire for an aerial, especially out in the country, away from man-made interference. It is hoped that this series of articles may have put some useful ideas into the heads of those contemplating some mobile equipment, even if they do not fancy the idea of duplicating the original equipment.

Signal Generator

(Continued from Page 31.)

ratios were incorrect. It was merely half an hour's work on the values of the timing condensers to set them right again, after which the frequency of the output pulses was found to be very close indeed to the mains frequency.

Because of this, it is recommended that before the dividers are adjusted, provision be made for adjusting the frequency of the master oscillator. This can be done very simply by putting a bleeder across the H.T. line, comprising a 10k. potentiometer, at the H.T. end, and a 10k. fixed resistor to earth from its lower end. The grid leaks on the master oscillator valves are then removed from the H.T. line, and instead are connected to the slider of the potentiometer. The potentiometer then acts as a smooth frequency control for the oscillator, enabling it to be easily set to frequency. Apart from gross frequency errors like the one described, considerable frequency changes can be made without the dividers slipping to wrong ratios.

(To be continued.)

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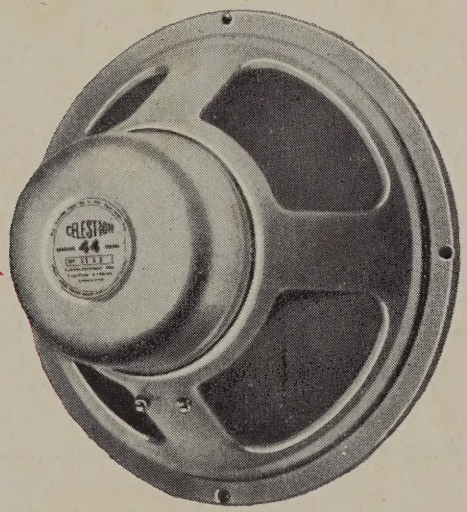

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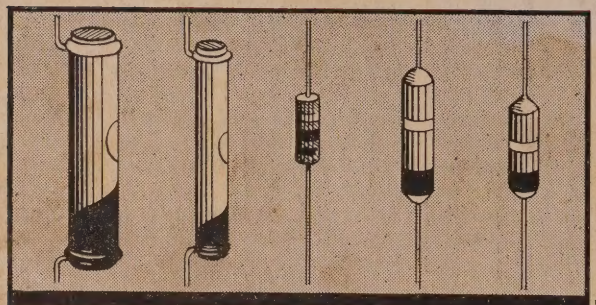

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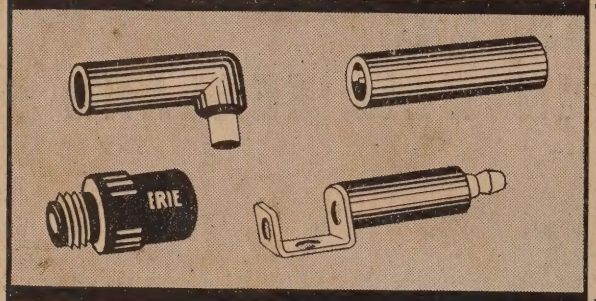

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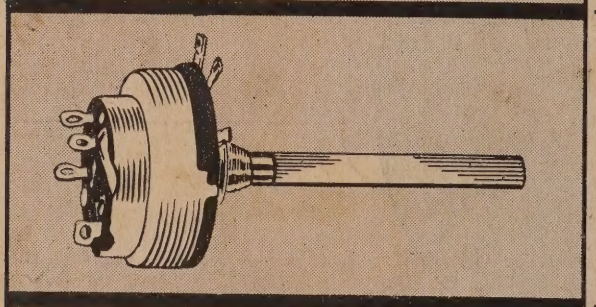

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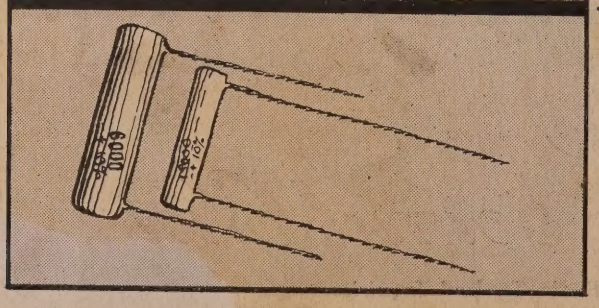
Erie Potentiometers are of the carbon-track type and embody a carbon-sprayed bakelite element with a maximum overall dissipation of one watt, and are available in values from 2,000 ohms to 2 megohms inclusive, either with or without switches, which are of the S.P. Singe Throw and D.P. Single Throw types only.



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